



THINK

Thoracic Issues in Neonatal Kittens

THINK was started by a group of breeders and a vet who were concerned by illness and deaths in young kittens caused by conditions such as Flat-chested Kitten Syndrome (FCKS). The organisation has four main objectives: to Identify the various types of thoracic deformities that occur in kittens, Educate the general public and the veterinary profession about thoracic deformities in kittens, Fund research and help breeders and vets to Treat the condition.

Identify FCKS occurs sporadically in all breeds of cats including non-pedigree cats, and is therefore of concern to every breed and breeder in the cat fancy. It can affect kittens without warning, from parents who have shown no sign or indication of producing kittens with the problem, and from repeat matings that have previously produced only healthy kittens. It can affect only one kitten, or it may affect whole litters; kittens may recover or they may die. There are few references to this condition in the veterinary literature; as a result veterinary professionals do not always recognise the condition, and breeders sometimes have to find out about it by themselves when they discover they have a kitten that they think is affected.

The condition is often confused with pectus excavatum (an inverted sternum), also known as funnel chest. Flat chested kittens sometimes have pectus excavatum as well, but it is a different condition although the two may be related. Other thoracic deformities are also reported in kittens and sometimes accompany a flat chest. They can also appear independently. One of the objectives of the group will be to clearly identify and define each known thoracic condition in kittens.

Educate breeders and the veterinary profession An important part of any research group is the ability to bring together existing knowledge and new information so that it can be used to inform the public and the veterinary profession. A clear and precise description (phenotyping) of thoracic conditions that may affect kittens is essential in order to develop effective research projects and helping breeders and vets to understand the thoracic diseases that affect kittens. One of our primary objectives is to contact all veterinary surgeries in the UK, and eventually much further afield, with a data sheet describing thoracic deformities, and inviting the profession to participate in returning data to our research team that will allow new conditions to be identified, breed prevalences to be established and effective methods of management developed.

Fund multi-disciplinary approaches to the problems All this is going to cost money, and our medium-term goal is to establish a post-doctoral research post at a University Veterinary School to look for underlying causes of FCKS and other thoracic deformities. At this stage it is essential that we keep an open mind and take a broad view as to potential causes. This will require an initial phase of information-gathering that will embrace all the possible causes: genetic, environmental, physical, dietary etc. and must include both healthy *and* FCK litters. By keeping an open mind, we increase our chances of success.

Treat and prevent conditions with the knowledge gained through research For every breeder who has suffered the loss of kittens with a thoracic deformity, their most urgent wish is that a treatment may be found to help kittens that develop this condition. If we know more, we should be able to treat these kittens, but more importantly we hope to be able to prevent the condition from developing by identifying causes and risk factors including any underlying genetic influences. If breeders and vets are better informed, they will be able to identify the condition earlier, thus improving the chances of success for any treatment. Many breeders have been gathering data for several years, and by sharing information about the progress of kittens with flat chests, have tried many ways of supporting affected kittens. Although some treatment regimes have been successful, few breeders and veterinary surgeons know about them, and sadly many kittens still die of flat chests and related problems.

Because of the huge cost of funding a research post, the THINK group understands that there are no quick solutions. We have to raise at least £300,000 and we recognise that this cannot all come from the general public. We therefore need to establish a body of data and inform all those who come in contact with kittens before approaching major funding bodies with a well-devised plan of research. All this will take time and money, and this is where you can help. Become a *Friend* or *Sponsor* (*Sponsors* will be listed on our website) of THINK today, and be part of something that may one day save the lives of your kittens.

www.think-project.org

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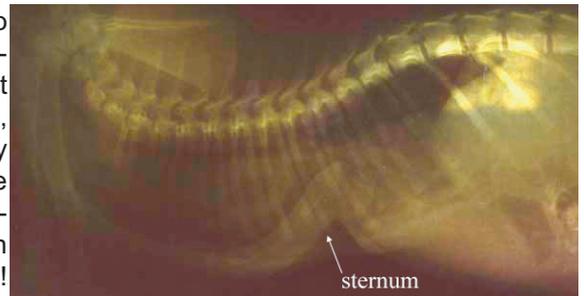
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What are thoracic deformities?

The thoracic deformity best known among cat breeders is FCKS, or Flat-Chested Kitten Syndrome, but FCKS is just one condition: breeders with flat-chested kittens are usually concerned about the flat ribcage, and may not be aware that a kitten may also have kyphosis (a dip in the spine behind the shoulder-blades) or *pectus excavatum* (an inverted sternum) as well. For this reason the research envisioned by the THINK project embraces all thoracic deformities, since they may be related. In the course of our investigations other thoracic deformities may become apparent. Equally FCKS may be the end product of a variety of different processes such that the causes of FCKS in one breed may not be the same as in a different breed thus requiring different preventative measures and treatment regimes.

Some vets and breeders use the term *pectus excavatum* (PE) to describe FCKS, this is incorrect, as the two are in fact different conditions and can occur independently or simultaneously: a flat chest is not the same condition as an inward-turning sternum. Kyphosis, a dip in the spine just behind the shoulders, similarly may appear by itself or in conjunction with FCKS. By itself it does not seem to be life-threatening, but it can affect the growth of the front half of a kitten's body. This radiograph shows the ribcage (or thorax) of a kitten with PE, FCKS and kyphosis; the kitten survived all these problems!



In FCKS the underside of the ribcage flattens and sometimes curls inwards. In extreme cases, the kitten will start gasping for breath and will die if untreated. There are degrees of flat-chestedness, with kittens in the same litter

Fig. 1: Normal Thorax

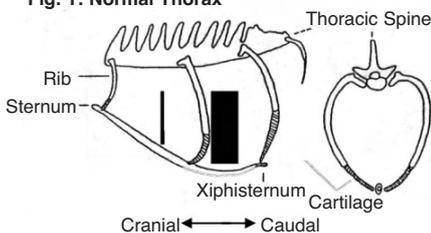


Fig. 2: Pectus Excavatum

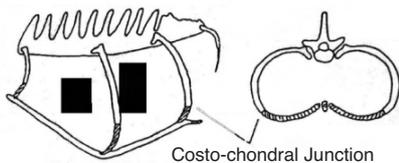
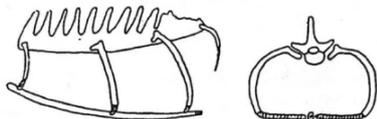


Fig. 3: Flat Chest



being affected to varying extents. If the ribcage collapses inwards, lung and heart function become compromised. Many slightly flat-chested kittens go unnoticed and recover on their own. Some kittens that appear to do well at first nevertheless die. The two diagrams here, showing the difference between *pectus excavatum* and FCKS were produced in a veterinary study that was commissioned by the Burmese Cat Club. FCKS is not limited to cats: piglets suffer from flat chests and so do humans. Although swimmer puppies and kittens can look similar to FCKS, deformities of the rib cage are not part of the primary disorder. If we can define the underlying processes that lead to a flat chest, there is the potential to help many other animals and people.

Kyphosis and PE are both deformities of the bone, and cannot usually be corrected, although surgical correction of PE is reported in older kittens. FCKS is thought to be associated with the muscles between the ribs (intercostal muscles) and possibly the diaphragm, resulting in an otherwise normal ribcage being pulled into an abnormal shape thus preventing normal chest movement. In FCKS the whole volume of the chest cavity is reduced, affecting the amount of air that is moved in and out of the lungs with each breath (tidal volume). Less oxygen is delivered to the blood stream and the kitten tries to compensate by breathing faster. As a result, severely affected kittens appear to be panting.

How can I tell if a kitten has FCKS or another thoracic deformity?

Bony deformities are reasonably easy to spot: PE is not always very obvious, but a kitten with the condition often has a dip in the centre of its chest (see illustration below), like the entrance of a funnel, hence its lay name, funnel chest. PE, Kyphosis, & FCKS become apparent shortly after birth: if kittens are checked frequently it is possible to see almost immediately when the rib-cage has flattened or dipped. Flattening is often not present at birth but will usually become apparent within 2–5 days; the point at which it is noticed may be related to the severity. Flattening can appear to occur suddenly over a few hours or gradually worsen over several days. By feeling the sides of the ribcage with the fingers it is possible to detect the flattening before it is associated with obvious breathing changes as there is a ridge running long ways at the sides of the ribcage. Flattening can also be detected by comparing the dimensions of the chest with other kittens in the litter. In all kittens there is a slight ridge running along the ribcage where the bony rib meets the cartilage that attaches to the sternum. This is more obvious in some kittens but does not necessarily mean that they are flat chested.

Kittens with thoracic deformities use up far more energy breathing and moving than normal kittens. Often an early sign that something is wrong is a failure to gain weight because they are too tired to fight for a teat, to suckle for long enough or are reluctant to feed as they can not breathe and swallow at the same time. Many breeders have found that supplement feeding seems to help FCKs, even if they seem to be feeding normally from the mother.

Knowing what FCKs looks like in a diagram does not always help to work out if a kitten is suffering from the condition. However, a reasonably fresh banana can give some idea of what a flat ribcage feels like. Hold the banana with the flattest side downwards (usually on the inside of the curve), and draw your hand upwards. The outside of the skin has two clear ridges at the lower edge, and the bottom is flatter than the sides and top. This is almost exactly what a mildly flat chest feels like (even down to the size) only with a covering of fur.

Normally the flat chest is simply that: flat. But if the condition is severe the sternum and ribcage can be collapsed into the chest cavity. This can compromise the function of the heart and lungs and potentially could affect the development of the cardiorespiratory system. This collapse is one reason the condition is sometimes misdiagnosed as *pectus excavatum*, but the collapse affects the whole length of the rib cage rather than being centred on the most backward point (xiphisternum) as in PE. Kittens with this advanced form of FCKs will not usually survive without active intervention.

There is another condition (apparently unrelated to FCKs) in which the sternum grows outwards, and may 'float', and though this apparently has no health implications, it is considered a veterinary fault. There are also other deformities that are not described here, which may or may not be related.

Which breeds are affected? Absolutely ALL breeds of cat can sporadically produce kittens with thoracic deformities, including non-pedigree cats. However, some breeds, seem to be more prone to the problem, or their breeders are perhaps more open about discussing it. FCKs is one of the better-known deformities partly because it is estimated that approximately 50% of affected kittens die from the condition. Breeders from every country in the world have had experience with FCKs, so there are no boundaries and it could happen to anyone. It is very important to understand that these deformities are nobody's fault. Kittens with FCKs and/or other thoracic deformities can turn up completely unexpectedly in matings that have never had problems before.

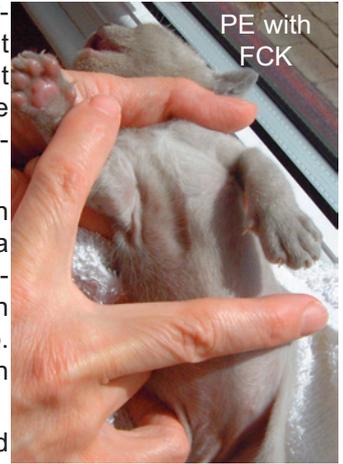
Why does FCKs happen? This is the most important question that we need to answer. The short answer is that we don't know why some kittens develop FCKs and some do not. It could be genetic, but it may be environmental, or it may be neither of these or a combination of both. We cannot find out the answers until we have a really significant body of data to work with, and that means gathering information from as many sources as possible.

Various causes have been suggested for the abnormal development or behaviour of the ribcage in FCKs. The Burmese Cat Club funded research into taurine deficiency which, though it only had a very small study group to work with, concluded that it was probably not relevant, although both FCKs & their littermates did show higher than usual levels of taurine. Other theories have suggested potassium deficiency, but treatment with potassium supplements have not shown consistently significant results in treating the condition, and blood samples have not indicated a deficiency. It is also possible that a flat chest is the end result of a variety of different disease processes so that the cause of FCKs in one breed may not be the same as in another breed. FCKs could also occur be a random congenital deformity in some cases unassociated with that kitten's genetic make-up.

Although a variety of, often implausible, causes for FCKs have been suggested (such as queens lying on heat pads or heated floors during pregnancy); none of these theories have been proven. It is possible that a mating with the potential to result in FCKs will have increased numbers of affected kittens associated with certain environmental conditions, but it can be clearly seen that some cats will throw FCKs and some will not, while some cats will have FC kittens in one litter, but not in another that is a repeat mating without any obvious environmental changes having been made.

Is this problem genetic? Some lines appear to throw FCKs far more than others; virtually all studs in all breeds have thrown one at some time or another (because of the numbers of kittens they sire), so it's unavoidable, and abandoning ALL lines that have thrown FCKs could be incredibly damaging to any breed as it would limit the gene pool far too much. Having the condition manifest in a litter of kittens may rely on combinations of environment and many other factors, including the situation of the queen: any adverse event or stress during pregnancy (including poor nutrition) may render a queen more liable to produce FCKs, particularly if a litter is partially resorbed, while a less stressful environment may prevent the condition from developing. If just one flat-chested kitten appears in an otherwise normal litter then the causes could be environmental more than genetic. If a whole litter of kittens has FCKs it would be advisable not to repeat that mating, and if possible not to continue using those cats for breeding if they continue to produce kittens with the condition even when mated to other cats.

Many breeders prefer only to use lines which are considered to be FCKs-free, even though this may severely limit their gene pool (and there are many dangers for the cat population in following this course), but sometimes a kitten will turn up in a line that was thought to be clear, showing that it can be difficult to avoid the problem completely.



Will my kittens die?

Following the development of FCKS, the outcome is unpredictable. Since onset of FCKS is fairly soon after birth, you will know quite quickly which kittens in the litter are affected and which will remain normal. A kitten may not survive the onset of the condition or it may appear to be doing well and then die suddenly at around 10 days old or thrive up to three weeks of age and then fade and die. If kittens survive beyond three weeks, then the likelihood is that they will survive to adulthood; the ribcage frequently reverts to a normal shape (meaning that it can be impossible to distinguish a kitten that suffered with a flat chest from normal when it is an adult), or may remain flat into adulthood with no apparent side-effects. Rarely, severely affected kittens that are significantly under grown at 3 weeks will die in late kitten hood. As far as we know, a recovered FCK that is of average size and has a normal ability to exercise will have every expectation of a normal life. Similarly *pectus excavatum*, if severe, may compress the lungs and heart; if a PE kitten survives, it may never grow quite as large as its normal siblings.

What can I do about this?

At present, it appears most likely that FCKS is a muscular problem. A variety of treatments have been tried to relieve the kitten's breathing difficulties and improve survival. With the exception of kittens that are gaining weight at a similar rate to normal littermates, supplementary feeding is recommended in all cases of thoracic deformity, even if the kitten appears to be feeding well, since these kittens are burning up far more energy than normal kittens just in the act of breathing (or trying to breathe). However, if the kitten fights against hand feeding or tube feeding you will have to judge whether the help given by the extra food is cancelled out by the stress and effort of struggling and the potential risk of food entering the airways rather than the oesophagus and stomach. If a kitten is hungry it will usually not fight seriously against supplementary feeding.

You can help THINK to find out the cause and thereby look for prevention and cure for thoracic deformities by completing a questionnaire about your kittens, both healthy and with FCKS, and sending it to us.

Life-saving solutions for FCKS

Breeders have saved kittens that seemed beyond help by splinting the ribcage using a cardboard or plastic tube. It is very important to be aware that if the sides of the ribcage are squeezed, this should cause the lower part of the chest to move outward, but if the sternum has already begun to collapse inwards, pressure on the sides may worsen the condition by pushing it in further instead of out. It is therefore important to understand that this procedure cannot be used with a funnel chested kitten or PE kitten, as it would push the inverted ribs further in. For this reason splinting should ideally be done under the guidance of a vet.

The first breeders to try splinting used a cardboard toilet roll, with holes cut for the front legs (which stopped it from slipping back off the ribcage). This was tied together over the kitten's back. Further refinements suggested that two flat pieces of card might have a better effect, as it would encourage the kitten to sleep on its side: as well as splinting, continually checking the kittens to make them lie on their sides may also be helpful, using gravity to help the ribcage round out correctly.

Other variations have involved using a splint made from a plastic drink bottle with tacky-bandage wrapped around it to protect the kitten's body. However it is done, splinting does seem to be a life-saving solution, with many kittens that were having breathing difficulties finding immediate relief. Work has been done in the Netherlands involving physiotherapy for 15 minutes every three hours, supported by steroid treatment. This also seems to have a good success rate, and should be investigated further. More details about treatments may be found on our website.

How can I prevent or avoid these conditions?

Don't be afraid to talk about FCKS if you have an affected litter. This is not something you caused, and it does not in any way mean you are a bad breeder, so it's nothing to be ashamed about. Only by discussing it openly will we learn more and discover why it happens. Nearly every breeder who has been breeding for some time will have experience of FCK, so even if you have not experienced it, it is worth finding out everything you can just in case. Things to try and avoid:

- Use of ANY medications including herbal and alternative remedies and food supplements during pregnancy or nursing unless they have been specifically shown to be safe, or the severity of the disease necessitates their use.
- Inbreeding (close line breeding), since FCK seems to appear more often in lines with limited genetic diversity.
- A queen whose kittens tend to show poor growth rates suggesting inadequate milk supply (if unavoidable, then supplement according to the kittens' growth rates).
- Breeding from a sire or queen that has had a number of litters affected with FCKS; Never breed from a cat who is a recovered FCK.
- Poor nutrition during pregnancy and nursing: plenty of fresh, high-quality food should be available to the queen at all times.



What can I do to help? THINK needs to raise funds for a dedicated research post at a senior level, so that the researcher already has the necessary skills, and can dedicate their time to investigating the problem without having to worry about completing an advanced degree or teaching at the same time. Although we plan to apply for funding from major grant-awarding bodies, the publicity and work of collecting and collating research data needs your help and financial assistance. You can help THINK financially by becoming a *Friend* or *Sponsor* (*Sponsors* are listed on the website), making donations, and practically by supplying us with information about your kittens, both with FCKS and normal (to provide a good body of control data) and assisting us in publicising our aims. Please notify THINK if you are dealing with a kitten, or litter of kittens with thoracic deformities. We may not have time to reply if you are just notifying a litter or kitten, but if you ask a question that is not covered here or on our website we will try to answer it. If you have any information you can add to this — anything from your experiences or thoughts on the notes above — then please contact us. Our kitten questionnaire is available to complete online or download, and copies can be obtained from project members at shows.

Although there are ways of treating FCKS, none are 100% successful: in order to succeed in curing every kitten, or better still, prevent the condition in the first place, we need to find out why it is happening.

It is likely that at least £300,000 will be needed to fund this research adequately (salary, overheads, consumables, lab and bench fees etc.), and we cannot expect to find the full amount from veterinary sources. Initially we need funds to gather primary data and organise a program of education through vets' surgeries, as well as bringing the scheme to public attention. If you would like to make a donation to the fund it is possible to do so through PayPal (any currencies) or by sending a cheque (GBP only) to the treasurer (details below).

Where will my money go? Newsletters are costly to produce and to post, so as THINK is not a cat club in the usual sense, the committee decided that people would prefer their money to be spent on supporting the project and eventually helping kittens, rather than sending chatty bulletins out to members. New information about thoracic conditions will therefore only appear on the website. This means that all fees and/or donations will be used for what is really important: a program of education directed towards finding out what causes thoracic deformities and curing them. In the early stages publicising the project is essential: this increases public awareness which will bring in donations and new members. It is also crucial that as many breeders and vets as possible help practically by completing questionnaires for healthy as well as FCKS litters, so that we have a really valuable body of data for our researcher to draw on when the time comes. We can also make a start on the research fund that will eventually go to pay for the research post.

There will be printing and postage costs as we need to produce information leaflets about thoracic deformities and questionnaires for both the general public and veterinary practices nationwide. We will need to pay for some professional veterinary consultancy to ensure we are asking the right questions for use in future research and we may have to pay a part-time professional research collator so that the information THINK gathers is organised correctly for research use.

Although we don't yet know exactly what information we will need to gather, this may involve members of the project team visiting litters of affected kittens (with permission) to make measurements or physical observation; it may involve taking swabs (which we will have to buy and pay for posting), and all this costs money in travel expenses and postage, since we can't expect volunteers to use their own money for travel, even though many will do so. Any information made available to THINK is entirely voluntary, and will be completely confidential. The names of breeders or bloodlines would never be released without express permission.

When the time comes to make a presentation to a University veterinary school or a major funding body to establish our research post, there will almost certainly be costs involved: we want our organisation to be well prepared and to make the best impression to convince them that we are a serious and well-run project, and their money will be put to good use. If we manage to secure funding we will need to advertise the post widely to make sure we get the best person for the job.



www.think-project.org

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Online payments through www.PayPal.co.uk: THINK.project@gmail.com

Please send completed questionnaires to:

THINK Research Collator, The Old Post Office, Cottam, Retford, Notts DN22 0EZ

To contact the project directly please e-mail THINK.project@gmail.com

This leaflet was compiled under the supervision of a veterinary surgeon

