

# What prevents baby from breathing under water?



Waterbirth Basics

From Newborn Breathing to Hospital Protocols

© Barbara Harper 2000

Printed in Midwifery Today: Issue 54, Summer 2000

Waterbirth is simple.

Within the simplicity of water labor and birth lies a complexity of questions, choices, opinions, research data, women's experience and practitioner observations.

Over the past five years as more hospitals within the United States examine waterbirth and create programs to support the use of water for labor and birth, newspaper reporters latch onto the sensationalism of this simple option and publish stories of successful waterbirths in local publications. Each reporter does their best to simplify waterbirth and at the same time answer the most common questions. Each story shows a happy beaming mother, a quiet peaceful baby and a proud father, who usually successfully set up a portable birth pool. The surprise headlines like, "watery birth" or "baby's birth goes swimmingly" or "junior

makes a splashy entrance," are countered with the simple stories of couples who have made this decision for themselves and are proud of it.

The first and foremost question in everyone's mind and the lead in all of these newspaper accounts is simple: How does the baby breathe during a waterbirth?

There are several factors that prevent a baby from inhaling water at the time of birth. These inhibitory factors are normally present in all newborns. The baby in utero is oxygenated through the umbilical cord via the placenta, but practices for future air breathing by moving his intercostal muscles and diaphragm in a regular and rhythmic pattern from about 10 weeks gestation on. The lung fluids that are present are produced in the lungs and similar chemically to gastric fluids. These fluids come out into the mouth and are normally swallowed by the fetus. There is very little inspiration of amniotic fluid in utero. 24-48 hours before the onset of spontaneous labor the fetus experiences a notable increase in the Prostaglandin E2 levels from the placenta which cause a slowing down or stopping of the fetal breathing movements (FBM).[1] With the work of the musculature of the diaphragm and intercostal muscles suspended, there is more blood flow to vital organs, including the brain. You can see the decrease in FBM on a biophysical profile, as you normally see the fetus moving these muscles about forty percent of the time. When the baby is born and the Prostaglandin level is still high, the baby's muscles for breathing simply don't work, thus engaging the first inhibitory response.

A second inhibitory response is the fact that babies are born experiencing acute hypoxia or lack of oxygen. It is a built in response to the birth process. Hypoxia causes apnea and swallowing, not breathing or gasping. If the fetus were experiencing severe and prolonged lack of oxygen, it may then gasp as soon as it was born, possibly inhaling water into the lungs.[2] If the baby were in trouble during the labor, there would be wide variabilities noted in the fetal heart rate, usually resulting in prolonged bradycardia, which would cause the practitioner to ask the mother to leave the bath prior to the baby's birth.

Another factor which is thought by many to inhibit the newborn from initiating the breathing response while in water, is the temperature differential. The temperature of the water is so close to that of the maternal temperature that it prevents any detection of change within the newborn. This is an area for reconsideration after increasing reports of births taking place in the oceans, both now and in eras past. Ocean temperatures are certainly not as high as maternal body temperature and yet the babies that are born in these environments are reported to be just fine. The lower water temperatures do not stimulate the baby to breathe while immersed.

One more factor that most people do not consider, but is vital to the whole waterbirth and

aspiration issue, is the fact that water is a hypotonic solution and lung fluids present in the fetus are hypertonic. So, even if water were to travel in past the larynx, they could not pass into the lungs based on the fact that hypertonic solutions are denser and prevent hypotonic solutions from merging or coming into their presence.

The last important inhibitory factor is the Dive Reflex and revolves around the larynx. The larynx is covered all over with chemoreceptors or taste buds. The larynx has five times as many as taste buds as the whole surface of the tongue. So, when a solution hits the back of the throat, passing the larynx, the taste buds interprets what substance it is and the glottis automatically closes and the solution is then swallowed, not inhaled.[3] God built this autonomic reflex into all newborns to assist with breastfeeding and it is present until about the age of six to eight months when it mysteriously disappears. The newborn is very intelligent and can detect what substance is in its throat. It can differentiate between amniotic fluid, water, cow's milk or human milk. The human infant will swallow and breathe differently when feeding on cow's milk or breast milk due to the Dive Reflex.

All of these factors combine to prevent a newborn who is born into water from taking a breath until he is lifted up into the air.

So, what does happen to initiate the breath in the newborn? As soon as the newborn senses a change in the environment from the water into the air, there is a complex chain of chemical, hormonal and physical responses, all resulting in the baby breathing. Water born babies are slower to initiate this response due to the fact that their whole body is exposed to the air at the same time, not just the caput or head as in a dry birth. Many midwives report that water babies stay just a little bit bluer longer, but their tone and alertness are just fine. It has even been suggested that water born babies be given the first APGAR scoring at one minute thirty seconds, not at one minute, due to this adjustment.

There are several things that happen all at once for the baby. The shunts in the heart are closed; fetal circulation turns to newborn circulation; the lungs experience oxygen for the first time; and the umbilical cord is stretched causing the umbilical arteries to close down. Nursing and medical schools taught their students for years that the first breath was dependent on the pressure of the passage through the birth canal and then a reflexive opening of the compressed chest creating a vacuum. That action has no bearing on newborn breathing whatsoever. There is no vacuum created. The newborn who is born into water is protected by all the inhibitory mechanisms mentioned above and is suspended and waiting to be lifted up out of the water and into mother's waiting arms.

All the fluids that are present in the lung alveoli are automatically pushed out into the vascular system from the pressure of pulmonary circulation, thus increasing blood volume for the newborn by 1/5th or 20%. The lymphatic system absorbs the rest of the fluids through the interstitial spaces in the lung tissue. The increase of blood volume is vital for the baby's health. It takes about six hours for all the lung fluids to disappear.[4]

When we look back at the analysis of the statistics of babies born in water it proves that these inhibitory factors are more than theories. A study conducted in England between 1994 and 1996, and published in 1999, reports on the outcomes of 4032 births in water. Perinatal mortality was 1.2 per 1000, but no deaths were attributed to birth in the water. Two babies were admitted to special care for possible water aspiration.[5] From 1985 to 1999, it is estimated that there have been well over 150,000 cases of waterbirth worldwide. There are no valid reports of infant deaths due to water aspiration or inhalation. In the early days of waterbirth a baby was reported as dying from being born in the water. This particular newborn death was caused not by aspiration, but by asphyxiation due to leaving the baby under the water for more than fifteen minutes after the full body was born. At some point the placenta detached from the wall of the uterus and stopped the flow of oxygen to the baby. When the baby was taken out of the water, it did not begin breathing and could not be revived. On autopsy the baby was reported to have no water in the lungs and its death was attributed to asphyxia.[6]

This is the reason that we bring babies up out of the water within the first few moments after birth. Some people have commented on the long time that some babies remain in the water in the film, "Water Babies: The Aquanatal Experience in Ostend." Video tape is deceiving, but so are our senses. When timed, the film sequence is only forty-seven seconds, but when viewers are asked to judge how long the sequence of immersion for the baby really is, reports range anywhere from one minute to five minutes.

Bringing a baby out of the water too quickly can be just as traumatic but it can also lead to either torn or broken cords. This has been reported by a number of midwives and doctors.[7] If the practitioner is not looking for a torn cord the possibility of the baby needing a transfusion increases. Torn or broken cords can be avoided by bringing baby out of the water slowly and gently. Mothers who desire to pick up their own babies need to be reminded to not do it too quickly, either.

The inability to accurately assess blood loss in the water is a reason that some midwives have stated for either not "allowing" the birth to take place in the water or asking mother to get out right away after the baby is born. Blood loss assessment is easy to judge after a few births. Garland and Jones report in a review of waterbirths at Maidstone Hospital in Kent, England, that the midwives are much better at judging and reporting blood loss in the water after experiencing over 500 births.[8] A useful key to judge post-partum hemorrhage is how dark is the water getting? Can you still assess skin color of the mother's thighs even though there is blood in the water? A few drops of water in a birth pool diffuses and causes it to change color. A waterproof flashlight comes in handy at this point. Dropping a flashlight onto the bottom of the birth pool allows you to look for bleeding as well as meconium during the birth. It also helps you spot floating debris and remove it.

Which brings us to the second most frequent question among hospital nurses and newspaper reporters: Won't the mother get an infection?

There are still hospitals that restrict a woman from laboring in the water if her membranes are ruptured. This is totally absurd based on the current and past literature. There is no evidence of an increase in infectious morbidity with or without ruptured membranes for women who labor and/or birth in water. [9] [10] The oldest reference that researches the possibility of infection during a bath is mentioned in a 1960 American Journal of OB/GYN. Dr. Siegel posed the question, "Does bath water enter the vagina?" In his experiment he placed sterile cotton tampons into thirty women and then asked them to bath in iodinated water for a minimum of fifteen minutes. In all cases when the tampons were removed, there was no iodine present.[11] His conclusion states, "we can now stop restricting women from bathing in the later stages of pregnancy and labor." Laboring mothers have an advantage when the baby is descending and moving out. Nothing is moving up and in. Things that we put into laboring vaginas may cause an increase in infections, such as probes, fingers, amnihooks, scalp hooks, etc. Janet Rush, RN, and her Canadian group of investigators have conducted the only randomized controlled trial of the effects of water labor. They reported that there were no differences noted in the low rates of maternal and newborn signs of infection in women with ruptured membranes.[12]

Infection control, especially in a hospital setting, requires diligence and the following of strict protocols between and during births. Cleaning and maintaining all equipment used for a waterbirth will prevent the spread of infection. In a random study conducted at the Oregon Health Science University Hospital in 1999, cultures were done from the portable jetted birth pool before, during and after birth, as well as from the fill hose and water tap source. In all instances no bacteria cultured from the birth pool but the water tap did culture *Pseudomonas*. [13] In a British study of 541 water labors no serious infections were reported during the three year period of data gathering. Again, *Pseudomonas aeruginosa*, was the only persistent bacteria discovered in two babies who tested positive from ear swabs. No treatment was necessary.[14]

Some parents are concerned about mother-to-mother infections or contamination from viruses

such as HIV or Hepatitis. There is no reason to restrict an HIV positive mother from laboring or giving birth in water. All evidence indicates that the HIV virus is susceptible to the warm water and cannot live in that environment.[15] Universal precautions still need to be adhered to and proper cleaning of all the equipment after the birth needs to be carried out.

Using disposable liners has become the norm for use with portable birth pools, but attention must also be paid to proper cleaning of drain pumps, hoses, filter nets, taps and any other items that are reused from one birth to the next. The issue of cleaning the jets of permanently installed baths has generated some concern and discussion over the past few years. Many hospitals remodeled their labor units in the late eighties or early nineties, installing jacuzzi-type whirlpool baths. These baths are great for women in labor, but often are not deep enough or are situated within very small bathroom spaces, boxed in and making birth in them difficult in all respects. The protocol for cleaning jetted tubs is simply to completely clean the tub with a quaternary ammonium solution, refill with water and add some kind of brominating agent to circulate through the jet system for a minimum of ten minutes.[16] A number of hospitals report that they use a half cup of powdered dish washing crystals such as Cascade and it works fine. Lynn Springer, RN, the perinatal coordinator for St. Elizabeth Hospital in Red Bluff, California, chose to install a beautiful corner Jacuzzi brand jetted bath on her unit in 1995. They have routinely performed monthly cultures of the bath and the jets throughout the past five years of their water birth program without any significant bacterial growth. They follow the above-mentioned cleaning protocol and report over 1000 water labors and 400 births in water.[17]

One issue that is repeated in the literature and voiced in the concern of mothers and their midwives is: When should the mother enter the bath?

Many hospitals use the 5-centimeter rule – only allowing mothers to enter the bath when they are in active labor and dilated to more than 5 cms. There is some physiological data that supports this rule, but each and every situation must be evaluated and then judged. Some mothers find a bath in early labor useful for its calming effect and to determine if labor has actually started.[18] The water sometimes has the effect of slowing or stopping labor if used too early. On the other hand, if contractions are strong and regular with either a small amount of dilation or non at all a bath might be in order to help the mother to relax enough to facilitate the dilation. It has been suggested that the bath be used in a “trial of water” for at least one hour and allow the mother to judge its effectiveness. Women report that often the contractions seem to space out or become less effective if they enter the bath too soon, thus requiring them to leave the bath. Then again, midwives report that some women can go from 1cm to complete dilation within the first hour or two of immersion.

Deep immersion seems to be a key factor. If the pool or bath is not deep enough, at least proving water up to breast level and completely covering the belly, then the benefits of the bath may be less noticeable. The warm water will still provide comfort and the mother will benefit from being upright, in control and drug free, but full immersion adds more physiological responses. The most notable being a redistribution of blood volume, which stimulates the release of oxytocin and vasopressin.[19] Vasopressin can also work to increase the levels of oxytocin.[20] The immediate pain reduction upon entering the bath is quite noticeable. It is what I refer to as, “the ahh effect.” The smile, the sound and the inner peace that mothers display are unmistakable. This response can happen at any point in the labor, but most notably when contractions are long and strong and close together. Some midwives who assume that there is little or no progress in dilation because the mother is not displaying any outward signs of discomfort are often surprised to find rapid dilation in the first hour of immersion. Having experienced a waterbirth myself, I can verify the incredible difference in perception of pain from the room to the water. When I am with a woman in labor I generally assess her pain on a scale of 1 to 10 before she enters the bath. Most report at least a 6 or greater. Then after no less than a half an hour, I will make another assessment. The second subjective answer of course varies from person to person, but the typical response is 2 to 4. The mother is experiencing more than the sum of her physiological responses to warm water immersion. Most women feel inherently safe in the water.

The water creates a wonderful barrier to the outside world. It becomes her nest, her cave, her own

“womb with a view.” If the pool is large enough to include her partner or husband, it then becomes an intimate place for the two of them to labor together and experience the love dance of birth. If the midwife or physician wants to do a vaginal examination while the mother is in the water, it is much easier for the mother to refuse. Her mobility allows her to move quickly to the other side of the pool. Vaginal exams can be easily done in the water, but for Universal Precautions to be maintained, long shoulder-length gloves need to be worn.

The control that women gain by being able to move freely in the water often aids them in assessing their own progress either through feeling the movements of the baby more intensively or actually being able to examine themselves internally. Women report that the water intensifies the connection with the baby at the same time that it reduces the pain. They can feel the baby move, descend and push through the birth canal. The prospect of the midwife becoming an active observer increases as mothers assume more and more responsibility for the birth and have the ease of mobility in the water. For many reasons, including reducing the risk of infection for the provider, many midwives suggest a hands-off birth for the mother. The water slows the crowning and offers its own perineal support.[21] This ‘minimal-touch’ approach also gives the mother a greater sense of controlling her own birth.

Perineal trauma is reported to be generally less severe, with more intact perineums for multips, but about the same frequency of tears for primips in or out of the water in some of the literature.[22] [23] One of the best benefits of waterbirth is the zero episiotomy rate that is reported throughout the literature. Rosenthal mentions that episiotomies can be done, but no one else offers this suggestion. The combination of being upright, having the mother in a good physiological position to birth her baby, giving her the freedom of control and not telling her to push when her body is not indicating it, all contribute to better perineal outcomes.

Midwives have a great deal of influence over the outcome of a birth. From the suggestions they make to a laboring mother to how they handle potential complications. There is an interesting phenomenon within the waterbirth movement that deserves some discussion. When a mother is laboring undisturbed, as Odent has written and lectured about, she will find her own place and time of birth, whether that place is the bathroom floor, under the piano, on the bed or in the bath. If practitioners remain silent observers to the process, the baby is born wherever it happens. But if the mother has stated her intentions for a waterbirth and the necessary arrangements have been made to have water available, is the midwife influencing the mother by reminding her as second stage approaches or in the middle of second stage that the bath is ready and waiting if she wants to get back in? In observing the statistics that Waterbirth International gathers from midwives and doctors on waterbirth, it is hard not to notice the variance from practice to practice. Those midwives that report an 80 to 90 percent waterbirth rate are usually set up with either a birth center facility which uses easily accessible bathtubs or every single one of their home birth clients rent or use portable birth pools. When the mother is in the midst of her subconscious birth responses, if someone tells her that the bath is ready and waiting, she often will immediately dash for the pool and climb in, even in the pushing stage. On occasion she simply states that nothing in heaven and earth can move her beyond where she is.

A midwife’s or physician’s hesitancy for using water for birth can also be felt by the mother and she often acquiesces just to make her practitioner feel more comfortable, instead of following her own instincts and staying in the water. Many women in hospitals get out of the pool because they don’t want to get their midwives “in trouble” by insisting on giving birth in water. And in the reverse, midwives often must insist that mother get out of the pool because protocols have not been set up for birth or the practitioner is just not comfortable with the process. The decision to birth in the water should be left up to the mother, but based on sound advice and assessment of fetal well-being by the practitioner. The mother who presents prenatally and is insistent that she is going to have a water birth no matter what, is usually destined to birth anywhere but the birth pool. I seriously counsel women who are taking on the system to evaluate their reasons for wanting to birth in water. If they are seeking to avoid pain only, that is a serious red flag and needs to be addressed on many different levels. If they have experienced one birth already and know what to expect and are looking for a better birth experience, then they are usually open to using the water

to be in greater control and seeing how they feel at the time of birth. Flexibility is always required in birth, but especially for those women who add the element of water. In my own case, the first time I felt that I wanted to birth in water because it was the best thing I could do for my baby. I hear many women say this and that is a reasonable motivation. But, the benefit that women derive from being in the water and gaining control over their experience is passed on to the baby. It is better to focus on the mother and what she needs. For my second waterbirth, no one could keep me out of the water. I was completely focused on my experience and not the baby's. Fathers will often call our office and make all the arrangements for the birth pool rental. On occasion that is because the dad wants his baby to be born in water and no other place, not taking into account what the mother really wants. Usually it all works out just fine, but occasionally it can influence the outcome of the labor.

Protocols differ from place to place, but as more experience with waterbirth emerges, we find that some previous reasons for asking a woman to leave the bath prior to birth are no longer hard and fast.

- Meconium used to mean that the mother would have to leave the pool to birth her baby on the bed to facilitate immediate suctioning. This requirement has relaxed a bit as it has been seen that meconium washes off the face of the baby and even comes out of the nares and mouth while the baby is still under the water. DeLee suctioning can still be accomplished as soon as the baby is up in mother's arms.
- Tight nuchal cords were a reason to ask mother to stand for the birth so that the practitioner could cut the cord and then deliver that baby. Now, the universal practice is to not even feel for a cord in a waterbirth, unless there has been a very slow second stage and you are afraid of cord compression. No attempt is made to clamp and cut the cord. The body is birthed and then the cord is unwrapped. It is amazing to watch a baby somersault and unwrap begin to unwrap their own cord in the expanse of the birth pool.
- Breech position was definitely a reason for a more controlled birth or even an automatic cesarean section. But there are practitioners throughout the world who recognize that there is increased safety for the baby if it is born in water. The most experienced doctor that we know of is Hermann Ponette, an obstetrician who practices at H. Surreys Hospital in Ostend, Belgium. He has attended well over 2000 waterbirths including breeches and twins. He uses a frank breech position as an indication for a waterbirth.[24] There are other reports of a few hospitals in the US attending breech waterbirths and approximately 50 reported breech births in water at home.[25]
- Shoulder dystocia is considered an obstetric or midwifery emergency by most practitioners. Protocols require mothers who are anticipating large babies to leave the bath. Now there is a growing body of experience that suggests that shoulder dystocia can be managed easier in the pool. Canadian midwife, Gloria Lemay, has written a protocol for management of shoulder dystocia in the water. It appears that tight shoulders happen more often because of practitioners or moms trying to push before the baby fully rotates. Position changes in the water are so much easier to effect and the mother doesn't panic but remains calm. A quick switch to hands and knees or even to standing up with one foot up on the edge of the pool if shoulders are really tight can help maneuver baby out.
- Prematurity has always been considered a reason for a controlled and monitored bed birth. Some doctors who have experienced the great results of waterbirth for babies born from 36 weeks gestation on, are now questioning whether waterbirth might be good for some babies who are less than 36 weeks gestation. With the advances for waterproof fetal monitoring there are fewer reasons to require a woman to leave the pool especially if her baby is tolerating the labor well. A few cases of waterbirth for 33, 34 and 35-week-old babies have been reported.

Once a woman has experienced a waterbirth she will more than likely want to repeat the experience. To that end, Waterbirth International gets some pretty interesting referral requests from women all over the world. If circumstances have changed and the mother is no

longer living in a place where waterbirth facilities or practitioners are readily available, she will go to almost any length to recreate the opportunity to give birth in water. A research project that Waterbirth International has been conducting for ten years is a survey of women who have given birth in water. On the survey form is a questions that states, "Would you consider giving birth again in water?" With over 1500 surveys collected, there has only been one woman that answered no to that question. On her particular survey she emphatically stated NO in bold print with two exclamation points and then drew an arrow down to the bottom of the page where in very small print she wrote, "this is number seven, I'm done!"

It is hard to think of another "method" of childbirth that receives such praise from women and practitioners alike. Dr. Lisa Stolper is an obstetrician practicing in the quaint New England town of Keene, New Hampshire. She began offering waterbirth to her clients at Cheshire Medical Center in October of 1998. One year later she reported an overall waterbirth rate of 37% for all vaginal births and 33% for all births, including cesarean sections. Her hospital has purchased just one portable jetted birth pool but they use it to labor almost 50% of their clients. They are now considering installing permanent pools to make it available for more women. Her comment about her job as an obstetrician was, "Waterbirth just makes my job so much easier."

One of the final questions that newspaper reporters pose and birthing couples ask is: Why aren't more hospitals in the US offering waterbirth?

Hospitals in the United States have made incredible advances in the waterbirth movement in the past five years. Monadnock Community Hospital in Peterborough, New Hampshire, was the first hospital in the country to embrace waterbirth and install a permanent birth pool, imported from England. They still offer this option to women and can now look back on almost ten years of great outcomes and lots of satisfied families. The rest of the country has taken some time and there are certain areas of the country that are making greater strides than others. In almost all cases where there are successful waterbirth programs going, they have been started by Certified Nurse Midwives. Midwives are more open to exploring the issue with their clients and doing the research necessary to get protocols accepted in hospitals. Some midwives have even purchased portable birth pool equipment with their own funds in hopes that it would pay for itself by generating more business. In most instances that investment has paid off. The whole US movement is at least five years behind the European movement in acceptance in hospital environments, but home birth midwives in the US have been offering waterbirth longer than most of their European counterparts.[26] The UK has had the benefit of government-sponsored research and data reporting as well as the Cumberlege Report.[27] The House of Commons Health Committee recommended that all hospitals should provide women with the option of a birthing pool. The underlying philosophy of the "Changing Childbirth" report recognized that women have the right to choose how and where they wish to give birth. In a 1994 statement, the UKCC stated, "...waterbirth is preferred by some women as their chosen method for delivery of babies. Waterbirth should therefore be viewed as an alternate method of care and management in labour and one which falls within the midwife's sphere of practice." [28]

The states that have made the most progress for hospital waterbirth are New York, Maine, New Hampshire, Illinois, Ohio, North Carolina and Massachusetts. Obviously, the East Coast is changing faster than the West Coast. It is surprising to some people when they find out that the whole state of California only has a handful of hospitals that provide waterbirth services. More than two thirds of the birth centers in the US offer waterbirth as an available option.

Mothers who call Waterbirth International wanting advise on how to get their particular hospital to allow them to have a waterbirth are advised that it takes three ingredients to make policy changes within a hospital setting.

1. A motivated mother
2. An open and supportive practitioner
3. A compassionate nurse manager or perinatal coordinator who is willing to take on the training of staff and the creation of new policy.

Waterbirth International will supply the necessary research studies, the sample protocols, the pool kits, the videos and the experience to help couples get policy changed, but without these first three components some hospitals will continue to deny the request. Time is the other factor. The more advance notice a hospital is given the better chances there are for change.

The final key to change is education. Waterbirth 2000: A Vision for the Future, an international waterbirth conference held in Portland, Oregon, September 21-24, 2000, will provide a forum for evaluating current waterbirth practice and discussing the needs of the both practitioners and the families they serve. There are so many areas of waterbirth to explore. Waterbirth is more a philosophy of non-intervention than a method or way to give birth. Waterbirth combines psychology, physiology, technology, humanity and science. Waterbirth is ancient and yet new at the same time. Waterbirth embodies a spiritual aspect of birth that is hard to express. Cynthia, who gave birth in water, said it better, "The water made me so completely connected to my body and my baby. The water held me and cradled me so that I could surrender more completely to this amazing and wonderful grace that was happening to me. This is the way that God intended childbirth to be."

---

© Barbara Harper 2000 – for reprints contact [barbara@waterbirth.org](mailto:barbara@waterbirth.org)

#### **Footnotes**

- [1] Johnson, Paul (1996) Birth under water – to breathe or not to breathe. *British Journal of Obstetrics and Gynecology*, Vol. 103, pp.202-208
- [2] Fewell, JE, Johnson, P (1983) Upper airway dynamics during breathing and during apnea in fetal lambs. *Journal of Physiology* Vol 339, pp 495-504
- [3] Harding, R., Johnson, P., McClelland, M. (1978) Liquid sensitive laryngeal receptors in the developing sheep, cat, and monkey. *Journal of Physiology*, Vol 277, pp 409-422
- [4] Karlberg, P. et al. (1987) Alteration of the infant's thorax during vaginal delivery. *Acta Obstetrica Gynecol Scandavia*. Vol. 41, p 223
- [5] Gilbert, R, Tookey, P, (1999) Perinatal mortality and morbidity among babies delivered in water: surveillance study and postal survey. *British Medical Journal* Vol 39, 21 August pp 483-487
- [6] Personal interviews (1989) Barbara Harper
- [7] Rosenthal, M (1991) Warm-water immersion in labor and birth. *Female Patient* Vol 16, August pp 44-51
- [8] Garland, D., Jones, K. (1997) Waterbirth: updating the evidence. *British Journal of Midwifery*, June Vol. 5, No 6 pp 368-373
- [9] Eriksson, M, Ladfors, L, Mattson, L and others (1996) Warm tub bath during labor. A study of 1385 women with prelabor rupture of the membranes after 34 weeks of gestation. *Acta Obstetrica et Gynecologica Scandinavica*, vol. 75, no 7, August pp 642-644
- [10] Garland, D., Jones, K. (1997) Waterbirth: updating the evidence. *British Journal of Midwifery*, June Vol. 5, No 6 pp 368-373
- [11] Siegel, P (1960) Does bath water enter the vagina? *Journal of Obstetrics and Gynecology*, Vol 15, pp 660-661
- [12] Rush, J., Burlock, S., Lambert, K., and others (1996) The effects of whirlpool baths in labor: a randomized, controlled trial. *Birth* September vol 23, no 3 pp 136-143
- [13] Personal communication with Polly Malby, CMN, 1999
- [14] Brown, L (1998) The tide of waterbirth has turned: audit of water birth. *British Journal of Midwifery*, April, Vol 6, No 4, pp 236-243
- [15] Favero, M (1986) Risk of AIDS and other STDs from swimming pools and whirlpools is nil. *Postgraduate Medicine*, Vol 80, No 1, p 283
- [16] Global Maternal/Child Health Association (1996 – revised Jan 2000) Procedures and Protocols for warm water immersion in labor and birth
- [17] Personal correspondence, Lynn Springer, RNC, 2000
- [18] Hadad, F (1996) Labor and birth in water: an obstetrician's observations over a decade from Waterbirth Unplugged, BFM Press, London pp 96-108
- [19] Katz, V., Ryder, R., Cefalo, R., Carmichael, S., Goolsby, R (1990) A comparison of bed rest and immersion for treating the edema of pregnancy. *Obstetrics and Gynecology* February Vol 75, No 2 pp 147-151
- [20] Odent, M (1998) Use of water during labor – updated recommendations. *MIDIRS*, March Vol 8 No 1 pp 68-69
- [21] Garland, D. (1995 – revised 2000) *Waterbirth An Attitude to Care* Books for Midwives Press, London p.
- [22] Burn, E., Greenish, K. (1993) Pooling information. *Nursing Times*, Vol 89, No 8 pp 47-49
- [23] Garland, D., Jone, K. (1997) Waterbirth: updating the evidence. *British Journal of Midwifery*, June Vol 5, No 6 pp 371
- [24] Ponette, H. (1995) Water births: My experience of 1600 waterbirths, including breeches and twins. Abstract published for the World Waterbirth Conference, Wimply Hall, London, England
- [25] Waterbirth International Practitioner Survey report (2000) - unpublished
- [26] Napierala, S. (1994) *Waterbirth: A Midwives Perspective*, Bergin and Garvey
- [27] Department of Health (1993) *Changing Childbirth Report of the Expert Maternity Group (The Cumberledge Report)* London, HMSO
- [28] UKCC (1994) Registrar's Letter Position Statement on Waterbirth