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Edward Reichman

The Halakhic Definition of Death in Light of Medical History

Much debate has recently taken place regarding the halakhic status of brain death. When this debate is ultimately consigned to history, it will be noted that the issue only became relevant in the late twentieth century, when the use of artificial respirators was commonplace; when, for the first time in medical history, brain death was temporally dissociated from cardiac death; when there was widespread confusion as to the differentiation between cortical and brain stem death; when the universal medical community underwent a major reassessment of the definition of death and decided to accept brain death criteria as valid. It will be important for one who confronts the large corpus of halakhic responsa literature generated on this issue to appreciate that a full understanding of each responsum can only be possible by taking into consideration its author's level of medical and scientific knowledge. In addition, for the reader of each responsum to clearly understand the discussion, he, himself, must also be fully conversant with the concepts and terminology used by the author, as he understands them. One is often guilty of superimposing current medical knowledge onto the words of predecessors, a practice which will inevitably lead to faulty interpretation. It is only by placing the responsum into its proper historical context that the reader can best be able to interpret it in its own right, as well as apply its ideas and conclusions to other contexts.

It is this principle of seeing a medical halakhic text in its own context that I wish to apply to the pre-twentieth century halakhic sources that deal with the definition of death.¹ It is not my intention to ad-

dress the halakhic ramifications of such an analysis, nor will I address the basic halakhic discussion of the determination of death. Discussion of the latter can be found in contemporary Jewish literature.²

The foundation and chronological starting point for any halakhic discussions is the Torah. While there are multiple biblical references to death³ and even resuscitation⁴, there is no clear statement of the halakhic determination of death. We, therefore, turn to the text of the Talmud as our historical point of departure for this issue, which we shall follow from the beginning until pre-modern times.

In many places, the Talmud discusses medical issues.⁵ Being that both the Jerusalem and Babylonian Talmuds were compiled while the Jews lived in the Greco-Roman empire, the world's center of medical practice and teaching (Galen [130-200 c.e.], the forefather of western medicine until modern times, whose often erroneous teachings remained undisputed for well over a thousand years, was roughly contemporary with Rav Yehudah ha-Nasi, the compiler of the Mishnah), the question arises as to the extent of cross-cultural borrowing. Were the Rabbis, in fact, familiar with the Greco-Roman sources?⁶ This can be determined either by explicit direct references to Greco-Roman authors or implicitly, by unattributed references to contemporaneous Greco-Roman theory and practice. I will analyze both of these possibilities and, in the process, will attempt to provide a general medical historical overview of some of the issues discussed in the halakhic literature on brain death.

It is first important to note that the medical topics addressed in rabbinic literature are only mentioned secondarily, in the course of halakhic or midrashic discussions. There are no primary Jewish or rabbinic medical treatises extant from the talmudic period.⁷ In addition, although the influence of the Greco-Roman medical tradition on the Talmud has been debated, it is abundantly clear, as will be partially evidenced in this paper, that Galenic medicine had a strong influence on post-talmudic halakhic and Jewish medical literature.⁸ As Galenic theories dominated western medical thinking well into the seventeenth century,⁹ spanning the period of the Rishonim and early Aharonim, a basic outline of Greco-Roman principles of anatomy and physiology will be helpful for interpreting medical halakhic discussions of this period in general, and of our topic, in particular.

Principles of Greco-Roman/Galenic Physiology¹⁰

1. THE DOCTRINE OF THE FOUR ELEMENTS, QUALITIES, AND HUMORS
Galen accepted the doctrine of the four elements—fire, earth, air and water—embodying the four qualities—hot, cold, dry, and wet—and

corresponding to the four essential humors of the body—blood, black bile, yellow bile, and phlegm.¹¹ Proper health, according to Galen, was dependent upon a delicate balance between and combination of these four elements, qualities and humors.

2. THREE SOULS

Galen perpetuated the Platonic idea of the three souls that both rule and serve the body. These are the rational, irascible, and concupiscible souls, situated in the brain, heart, and liver respectively. "The first presides over reasoning and thought and provides sensation and motion; the second controls the passion and is the vital force; and the third, also known as the vegetative soul, is in charge of nutrition."¹²

3. INNATE HEAT

The theory of an "innate" body heat was first suggested by early Greek medical writers. This "innate heat" became the "single most important motive power in the animal system." It was responsible for growth, digestion, movement, sensation and thought. The maintenance of "innate heat" coincided with life; its destruction coincided with death. The source of this "innate heat" was the heart, more precisely the left ventricle of the heart.¹³ Galen, too, granted paramount importance to this principle.¹⁴

4. PURPOSE OF RESPIRATION

The primary function of respiration according to Galenic physiology was to cool and conserve the "innate heat" of the heart. It was felt that this "heat" must be refrigerated by respiration and kept under control if life is to persist. If refrigeration is not provided, the heat will consume itself and the body will die.¹⁵

5. PNEUMAS OR SPIRITS

The basic principle of life according to Galen was a spirit or pneuma drawn from the air into the body through the act of breathing. The idea of the pneumas or spirits probably originated with Erasistratus, but the theory underwent significant alteration by Galen. This nondescript air travels to the heart where it meets the "innate heat".¹⁶ At this stage, it becomes the "vital" spirit and serves to cool the "innate heat". From the heart, the spirit travels to the brain where it undergoes further cooling and subsequent conversion into the "psychic" spirit, the source of intellect.¹⁷

It is important for our purposes to note that there is a direct relationship between respiration and cardiac function. The air inhaled ultimately reaches the heart itself.¹⁸ Furthermore, the heart appears to

initiate respiration by the following mechanism: "The heart expands through increasing heat, and thus causes expansion in the lungs and the air is drawn into the lungs and the heart." In sum, "the idea that the heart is an organ of respiration was established early in the history of Greek physiology and was still strongly entrenched in Galen's theory."¹⁹

6. FUNCTIONS OF THE HEART AND BRAIN

Aristotle, who wrote before the discovery of nerves, considered the heart as the center of the natural heat of the body. As a result, he considered it to be the primary cause of nutrition (i.e., transforming food into blood) and, more importantly, the controlling center of all sensation and movement in the body.²⁰ The brain was relegated to secondary significance.

Galen disagreed with Aristotle and proved experimentally that the brain is the source of sensation, respiration and movement, and not the heart.²¹ He did, however, agree with Aristotle that the heart is the seat of passion and the source of "innate heat".²² It is important to remember that the notion of the circulation of the blood through the body was only discovered in the 1600's by William Harvey.²³

7. CONTENT OF THE VESSELS²⁴

Galen proved experimentally that the vessels contain blood.²⁵ Many, however, maintained that the vessels contained air.²⁶

8. EMBRYOLOGY

Just as there was a debate regarding the organ responsible for movement and sensation (see # 6 above), there was, likewise, controversy about which organ appeared first in the developing fetus. Aristotle, as expected, believed that the heart formed first²⁷ while others thought that the head developed first.²⁸ Still others maintained that the fetus began growth from the navel, as it was attached to the umbilical cord,²⁹ from which all the other organs and limbs branched out. Galen, however, was alone in maintaining that the liver was the first organ to appear.³⁰

9. PULSE

Although Hippocrates does mention tangentially the observation of the apex beat,³¹ it was Praxagoras of Cos (300 B.C.E.) who first restricted the pulse to a distinct group of vessels and recognized its use as an indicator of disease.³² Galen wrote on the pulse in several of his treatises and discussed the value of palpating the pulse in the extremities and, in particular, in the wrists where it is easily felt.³³

Passage in Tractate Yoma

With this understanding of some of the elementary principles of Greco-Roman medicine, we can begin our analysis of the rabbinic sources on the determination of death. The *Talmud Yerushalmi* (Yoma 8:5) states:

Rav Zera and Rebbe Hiyya said in the name of Rav Yoḥanan: If one Jew lives in an area [enclosure] that is inhabited by non-Jews and a house collapses [there on the Sabbath], one is permitted to uncover the rubble. How far can one dig [before determining the death of the victim]? There are two opinions. One says until the nostrils because these are the source of life, and Ḥurna says until the navel because from here the body grows.³⁴

On one level, this discussion is simply medical in nature, the point of contention being how to assess if the person is still alive. Checking the nostrils for respiration is one alternative. Ḥurna, however, recommends examining the navel. However, how can inspection of this area be helpful from a medical perspective and what diagnostic information can be gleaned from such an examination? I propose two possibilities. First, one could theoretically be searching for pulsations of the abdominal aorta which is a reflection of heartbeat and simply another way of measuring the pulse. It is important to note, however, that although Galen and his peers may have routinely measured the pulse, nowhere in the Talmud, to the best of my knowledge, is there any mention of the taking of the pulse.³⁵ In addition, if one wished to take a pulse, the abdomen is not the ideal place to check, for the abdominal pulse will only easily be felt in an emaciated person: Galen was aware of this fact. To examine the pulse, one should better palpate the arteries of the extremities where the absence of fat or muscle allows for easier, more direct palpation. And, if searching for the direct beat of the heart was Ḥurna's intent, he perhaps should have stated so explicitly.

Secondly, it is possible to examine the abdomen for movement during respiration. With normal respiration, the diaphragm descends and the abdominal wall protrudes. Although this can be altered in pathological states, in a normal individual it can be easily observed, without the need for palpation. Although the Rabbis may not have understood the physiology of respiration, diaphragmatic excursion or abdominal wall motion, this would have been an easy way to search for movement.

This discussion can also be understood in a philosophical sense. Although, admittedly, the issue being decided is of pragmatic con-

cern regarding the violation of the Sabbath, there may be strong philosophical overtones that impact on that decision. Which area of the body is considered to be the origin or the source of life? One Amora claims that breath is the source of life, although no medical or biblical support for this notion is cited in the text of the *Yerushalmi*.³⁶ Consequently, it is this element for which we must search in the man underneath the rubble. This position may have its analogue in Greco-Roman physiology, as an example of the prime importance of the pneuma/spirit/breath in Galen's system mentioned above (#4 & #5). Ḥurna counters that one must uncover up to the navel, because it is from there that the body originates and gives forth the remaining organs and limbs.³⁷ This position of Ḥurna may have its basis in embryological notions of antiquity and is consistent with the position of Alcomaeon.³⁸

Other talmudic passages present opposing embryological views. In discussing where the point of measurement should be on the body of the deceased in the case of the 'eglab 'arufah, the Talmud (*Sotab* 45a) mentions a debate about the embryological origins of the fetus.³⁹ One position, buttressed by scriptural proof, maintains that the head is formed first. Abba Shaul, identifying with Ḥurna in the *Yerushalmi*, believes the navel to be the origin of the fetus. This passage, however, as opposed to the *Yerushalmi*, clearly differentiates between embryology and physiology. Abba Shaul may argue and maintain that the navel is the embryological origin of the fetus, but regarding the determination of the presence of life, even he would agree, the Talmud says, that the examination of the nostrils is the determinant. This latter notion is also supported by a biblical verse ("All in whose nostrils was the breath of life"; Bereshit 7:22).

These embryological views have analogues in the contemporaneous Greco-Roman world (see #8, above). In addition, the value of air, spirit or pneuma was paramount in the Galenic system of physiology, as mentioned above (#5). The air, which was ultimately converted to different pneumas, was breathed in through the nostrils.

However, the very enterprise of interpreting these rabbinic opinions in light of concurrent medical history is clouded by the citation of biblical verses as support for these opinions. Are these verses quoted as a reflection of a particular tradition about the definition of life or of man's embryological origins, or are they perhaps examples of "asmakhta", in which case they do not reflect a specifically unique tradition, and the verses are merely used to support positions consistent with contemporaneous medical knowledge? This is a truly crucial question for, if the former is true, then it not only renders our discussion futile but any discussion revolving around changes in medi-

cal/scientific understanding between our generation and that of the Talmud is out of place. We would be dealing not with talmudic medicine, but with biblical assumptions which clearly are not subject to the same type of historical analysis.⁴⁰ I appreciate the gravity and volatility of this issue, but will refrain here from addressing the theological implications and will confine myself solely to the historical aspects.

We now turn to the Babylonian Talmud's version of the passage (*Yoma* 85a). The Mishnah states:

If debris falls on someone, and it is doubtful whether or not he is there, or whether he is alive or dead, or whether he be an Israelite or a heathen, one should open [even on the Sabbath] the heap of debris for his sake. If one finds him alive one should remove the debris, and if he be dead one should leave him there [until the Sabbath day is over].

The Talmud then elaborates:

Our Rabbis taught: How far does one search? Until [one reaches] his nose. Some say: Up to his heart. If one searches and finds those above to be dead, one must not assume those below are surely dead. Once it happened that those above were dead and those below were found to be alive. Are we to say that these Tannaim dispute the same as the following Tannaim? For it was taught: From where does the formation of the embryo commence? From its head, as it is said "Thou are he that took me (*gozi*) out of my mother's womb," and it is also said: "Cut off (*gozi*) thy hair and cast it away." Abba Saul said: From the navel which sends its roots into every direction? You may even say that [the first view is in agreement with] Abba Saul, inasmuch as Abba Saul holds his view only touching the first formation, because "everything develops from its core (middle)" but regarding the saving of life he would agree that life manifests itself through the nose especially, as it is written: "In whose nostrils was the breath of the spirit of life." R. Papa said: The dispute arises only as to from below upwards, but if from above downwards, one had searched up to the nose, one need not search any farther, as it is said: "In whose nostrils was the breath of life".⁴¹

There are some fundamental differences between the *Bavli* and *Yerushalmi* versions, but for our discussion it is noteworthy that the *Bavli* substitutes the word *libo* (heart) for *tiburo* (navel).⁴² We must, therefore, again wonder what is being examined when one uncovers "up to the heart." Unlike the examination of the navel, there is no room for interpretation here. It is clearly the heartbeat that is either being palpated or listened for. We have mentioned that Hippocrates noted the apex beat (#9, above). However, similar to the abdomen, this is not the most reliable place to examine the heartbeat. The apex beat cannot always be seen or palpated even in the presence of a

normally functioning heart. The ribs and muscle prevent deep palpation. As was stated earlier, examination of the extremities, or perhaps the carotid arteries in the neck, is more reliable. In any case, checking for heartbeat is clearly what is being advocated.

The *Bavli* also attempted to parallel the debate as to whether one should search for life in the nares or the heart with the debate whether the head or the navel are of the earliest embryological origin. We have stated that these positions have antecedents in medical history. Implicit in this attempted parallelism, however, is the identification of the "navel" with the "heart". Applying the hermeneutic circle of analysis we can perhaps reinterpret the *Yerushalmi* position and suggest that the examination of the navel is actually a reflection of heartbeat, one of the alternatives we had suggested. The *Bavli*, however, subsequently rejects the parallel and clearly differentiates between embryology and physiology.⁴³

Position of Rashi

Rashi, like most Rishonim, explains the positions in the Talmud without explicit recourse to known medical theories or medical works. However, in his elucidation of the position requiring examination of the heart, Rashi makes a statement whose interpretation may be aided by an understanding of both medical history, in general, and of Rashi's unique anatomical understanding, in particular. He states:

One says to examine the heart for presence of life (*hiyut*) "*sbe-nishmato dofeket sham*"; and one says to examine up to the nostrils because sometimes life is not observed in the heart, yet is observed in the nostrils.⁴⁴

A proper understanding of this Rashi hinges on the interpretation of the phrase "*nishmato dofeket sham*". The word *nishmato* can mean either "his soul", a derivative of *neshamah*, or "his breath", a derivative of *neshimah*. Elsewhere Rashi adopts the latter usage⁴⁵, and I believe this usage to be contextually appropriate here as well.

Further support for the notion that *nishmato* refers to breathing is provided by the use of the term *dofeket*. This term, meaning "pulsates" or "beats", most likely refers to a physiological process. To associate the term *dofeket* with the soul would be awkward. In light of the above, Rashi claims that the heart is checked because the breath pulsates or is transmitted there. Therefore, when the heart is examined, its movement is a reflection of breathing; its *hiyut* a manifestation of respiration.

It follows that the heart is a respiratory organ and that Rashi subscribed to the notion that the inspired air ultimately reached the heart, ideas widely held throughout antiquity and the Middle Ages (see #4 and #6, above). While Galen and his followers had postulated an indirect route for the inspired air to reach the heart (above, n. 16), it appears that Rashi believed that there was a direct connection between the trachea and the heart. This is evident from his commentary on *Hullin* 45b: "Amemar said in the name of Rav Nahman: There are three vessels, one to the heart, one to the lung, and one to the liver." The three "vessels" mentioned could possibly refer to the vessels attached to the four chambered heart, i.e., the aorta, the pulmonary artery, and the inferior vena cava. Rashi, however, does not adopt this approach. He states: "There are three vessels; after the trachea enters the thorax, it divides into three."⁴⁶ Once the trachea enters the thorax, according to Rashi, it branches into three parts, one to the heart, one to the lung and one to the liver. The inspired air can reach the heart directly via one of the tracheal branches.⁴⁷ Rashi reiterates this anatomical understanding in other passages in his commentary on *Hullin*.⁴⁸

Rashi's anatomical approach does not correlate with contemporary understanding of anatomy, nor is there, to the best of my knowledge, any school in the history of anatomy that described the trachea as directly connecting to the heart.⁴⁹ In addition, anatomical dissection was not routinely performed during this period in history.⁵⁰ One can only fruitlessly speculate as to the source of Rashi's anatomical ideas.⁵¹

This particular inaccuracy of Rashi has been pointed out in the seventeenth century by Rabbi Isaac Lampronti.⁵² However, the notion of Rishonim, and Rashi in particular, espousing erroneous anatomical beliefs is not without precedent. The Hatam Sofer, in discussing the identification of the terms used by the Rabbis to refer to the female anatomy,⁵³ makes the following comment:

After searching through anatomy books and speaking with experts in anatomy, it is impossible to deny that the reality is not like the explanation of Rashi and Tosafot. . . . But after begging forgiveness from our holy Rabbis, they were incorrect in this matter. The truth is with [the position of] Maimonides,⁵⁴ as proven by experimentation by anatomists and as found in the anatomy books from expert physicians. . . . I have also asked physicians. . . .⁵⁵

Position of Rabbi Yehuda Aryeh of Modena

Until this point, I have attempted to place the talmudic passages in *Yoma* and *Sotah* into their medical historical milieu and to align, in a

general way, the embryological and physiological beliefs of the Rabbis with contemporaneous Greco-Roman theories. In addition, I have suggested that the *Talmud Bavli* in *Yoma* and *Sotah* differentiates between embryology and physiology.

Rabbi Yehudah Aryeh of Modena, who lived in the seventeenth century, also engages in the same method of analysis. In his eyes, however, the Rabbis are clearly and directly addressing the heart-brain debate of medical antiquity (see above, # 6 and # 8), both in terms of which has embryological precedence and in terms of which has greater physiological significance. Through this approach, his interpretation of the conclusion of the *Yoma* passage is quite remarkable, and is worthy of being cited in toto:⁵⁶

"From where is the fetus created, etc." Next to this passage [in *Yoma*], the author of '*En Ya'akov*' juxtaposes a passage from Tractate *Sotah*. I will address the reason for this juxtaposition. There are varying opinions amongst the [natural] philosophers regarding which organ of a developing fetus is created first. Some [i.e. Aristotle] say the heart, some say the liver,⁵⁷ and some say both of these together, [simultaneous] with the brain. And regarding the source of life (*mishkan ba-hiyut*), some say it is in the heart,⁵⁸ which is, therefore, called the king of all organs, and some [i.e. Galen] say it is the brain. The brain is in close proximity to the nostrils and a tube connects the two for the purpose of evacuating the phlegm, breath and pneuma from the brain.⁵⁹ That is why the brain has continuous motion⁶⁰ similar to the heart. . . .

Now, understand from this passage how the Tannaim engage in a similar argument. Regarding embryology, one says the fetus grows from the head, i.e., the brain, and one says from the navel, meaning to say the heart and liver. And, regarding the seat of life, one says from the nostrils, meaning to say the brain, and one says the heart. It is in this context that the Tannaim debated that when one checks to see if a person has died, and respirations are absent, one Tanna says check up to the nostrils and the other says check up to the heart. Rav Papa, however says that everyone agrees that the source of life (*hiyut*) is in the brain. Therefore, if one first checks the nostrils, which are functionally connected to the brain [as stated above], and there is no breath, everyone would agree that the brain is no longer functioning and the person is dead. . . . When do they argue? In a case when one reaches the heart first. In this case, one authority maintains that if the heart has stopped beating, surely this is a reflection that brain function has ceased as well, and the person is considered dead. The other authority claims that it is possible for pulsations of the heart not to be appreciated, yet the brain may still be functioning, as evidenced by the breath from the nostrils. [Therefore, one must check the nostrils even if he starts from the bottom up.]

The Torah, the source of truth, supports this position of Rav Papa with the verse, "all in whose nostrils is the breath of life", revealing that the

presence of breath in the nostrils indicates the presence of life.⁶¹ We see from here how the knowledge of the Rabbis covers all domains.

Rabbi Yehudah of Modena interprets the discussion in *Yoma* to be about the best method to determine brain death, albeit not the way we understand this phrase. According to one opinion, the absence of a heartbeat is an adequate assessment of brain death, while the other contends that the brain may still be functioning even in the absence of a discernible heartbeat. Therefore, according to the latter, the function of the brain must be assessed directly, by checking for respiration.⁶²

What is important from Rabbi Modena's words is not so much the details of his discussion as the methodology of his approach. He framed the talmudic discussion within the context of contemporary medical theory, thereby reaching a conclusion different from other rabbinic authorities.

The Mishnah in *Obalot* and Post-Decapitation Movement

The halakhic debate about the determination of death has also included discussion of rabbinic sources dealing with decapitation and post-mortem body movements. Brain death has been termed "physiological decapitation" and has, therefore, been argued to be analogous to the passages discussing physical decapitation.⁶³

The starting point for this approach is a *Mishnah* in *Obalot* (1:6):

Man does not spread impurity until his soul departs. Likewise for animals. If they are decapitated, even if they are "moving" they can spread impurity, similar to the tail of a lizard that "moves" independently.⁶⁴

Here the *Mishnah* discusses the halakhic relevance of post-mortem movement. It does not, however, detail the physiology of movement, nor does it reveal the origin or center that controls bodily movement. The Talmud (*Hullin* 20b-21a) elaborates on the case of "severance of the spine" in defining a *nevelab*. The issue raised is whether that state is sufficient to constitute a *nevelab* or whether severance of a majority of flesh in the neck area is also required ("rov basar 'imo"). Again, the discussion is halakhic and not physiological.

The Rambam, however, alludes to a coordinating center of movement whose control is lost with limb or tail amputation:

This creature moves its tail a great deal after it is severed. However, this occurs to a number of "species" whose source of movement is not

localized and coordinated from a central source but is rather spread throughout the body.⁶⁵

Although the Rambam refers to a central origin of movement, he does not reveal whether this origin is the brain, or the heart, or perhaps some other organ. From the Rambam's medical writings, however, it is clear what he believed to be the source of movement.⁶⁶

We have mentioned above (#6) the debate between Aristotle and Galen regarding whether the heart or the brain is the controlling center of sensation and movement. The Rambam explicitly addresses this controversy and supports the position of Aristotle:

I have prefaced [my remarks] with this introduction in order to stimulate you to [critically appraise even] a statement of the great sage Galen. You already know that his opinion is that there are three major organs, the heart, the brain, and the liver, and that not one of these can receive its power from another organ under any circumstances. The opinion of Aristotle and his followers is, as you know, that there is a single main organ, namely, the heart, and the heart sends powers to each of the other organs and, with this power, the other organs perform their specific functions. Therefore, according to the view of Aristotle, the heart sends powers to the brain and with this power the brain performs its function, and it [in turn] gives sensation and movement to other organs. So too the powers of imagination, thought, and memory are powers that are brought into existence in the brain through the principle that the brain receives from the heart. Similarly, all other organs in the body contain the powers with which they perform their special functions. This [thesis of Aristotle] is correct and logical because the brain performs its functions, and likewise every organ performs its functions, and all [together] they constitute the total life situation of an individual. However, the heart sends the specific power of life to each organ.⁶⁷

Another rabbinic figure roughly contemporary with the Rambam also addresses the Galen-Aristotle controversy. The thirteenth century Rabbenu Gershon b. Shlomo, father of the Raibag and son-in-law of the Ramban, cites multiple proofs for both sides of the controversy:

Galen claims that the source of movement is the brain, and he brings the following proof: He [i.e. Galen] once removed the heart from a monkey, and the monkey continued to move for twelve hours. It [therefore] appears that the source of movement is the brain. . . . There is also support for the position of Aristotle: After a man is decapitated, the remaining body can walk a few steps. So I was told by a Scholar who claimed to have seen with his own eyes that when a man was sentenced by the King to decapitation, he stated that after his head is severed, his body will walk to a designated spot. And so it was, the body walked to this spot and there it fell.⁶⁸

The post-decapitation movement mentioned in support of Aristotle is likely a reference to the Lazarus reflex which was first described for guillotine victims and later found to occur in brain dead patients as well.⁶⁹

The quote from Galen is also of historic and halakhic import. Whether the body can function without a heart or whether a heart can function without a body has long preoccupied the minds of anatomist and halakhist alike. Already in the second century, Galen observed that "the heart, removed from the thorax, can be seen to move for a considerable time."⁷⁰ In the sixteenth century, Andreas Vesalius, the premier anatomist of the Renaissance, described dogs and cats running around after their hearts had been excised.⁷¹ One century later, William Harvey, the discover of circulation, "proved by the frequent dissection of living animals . . . that when the animal was already dying and no longer breathing, the heart continued to pulsate for a while and kept some life in itself."⁷²

The Ḥakham Zevi and the "Heartless" Chicken

The discussion of whether an animal could live without a heart has occupied a prominent place in halakhic responsa literature as it relates to the status of an animal as *trefah* or *nevelah*.⁷³ A case in the year 1709 caused a great sensation when a young girl, preparing a hen for dinner, was unable to locate its heart. There was some suspicion that a nearby cat may have eaten it. The case was brought before R. Zevi Ashkenazi (Ḥakham Zevi) to decide if the hen was kosher. During the course of his discussion, the Ḥakham Zevi took the opportunity to elaborate on the importance of the heart, both from an halakhic as well as a physiological perspective.⁷⁴ His famous responsum on this subject has already been incorporated into the halakhic discussions of brain death, but I wish only to highlight a few of the medical historical elements.

It is interesting to note that this responsum was written after the discovery of the circulation of the blood, generally credited to William Harvey, yet no mention of this revolutionary discovery is found there.⁷⁵ The notion of the heart being the center of the circulation perhaps could have further buttressed his argument of the importance of that organ.

It is clear that the Ḥakham Zevi subscribed to the position of Aristotle. He writes: "All the life and power of the body are dependent upon it [i.e. the heart]. It is the first created and [life] is inconceivable without it." In addition, he quotes R. Gershon b. Shlomo's opinion, discussed above, regarding the case of the monkey whose movement

was observed twelve hours after the heart was removed: "Anyone who is the least bit familiar with science will realize that the words of the *Sha'ar ha-Shamayim* are the opinion of Galen." Aside from the fact that R. Gershon b. Shlomo explicitly attributed this position to Galen (see quote earlier in this article), it seems that the Ḥakham Zevi considered himself to have had at least minimal medical scientific knowledge which obviously included the teachings of Galen.

In discussing the talmudic passage in *Yoma*, the Ḥakham Zevi cites Rashi as support for his position.

Rashi z"l agrees with our words that the *nesbamab*⁷⁶ dwells in the heart. However, there are times when even if the *nesbamab* is still within the heart, the pulse may not be palpable on the chest [over the heart]. This may be secondary to the weakness of the pulsations, or because the heart is hidden underneath the chest wall, which prevents transmission of the pulse. But the *nesbamab* that exits the heart, by way of the lungs, can be observed as long as the heart is functioning. It is quite clear that there can be no *nesbamab* unless there is life in the heart. For *nesbamab* exists because of and for the purpose of the heart.

A number of important points can be gleaned from this last passage.

1. The Ḥakham Zevi acknowledges that the chest is not the best place to examine for heartbeat secondary to the interference of the ribs and muscle. As already indicated, this is consistent with medical teachings since antiquity and is equally true today as well.

2. He believes that the heart is a respiratory organ, also perfectly consistent with the medical understanding of his time. He, therefore, discusses the exhalation of air from the heart, via the lungs, to the outside. We have mentioned above that it was an accepted fact that the inspired air ultimately reached the heart.

3. It seems evident that the Ḥakham Zevi understands the Rashi as it was explained above, i.e., we check the heart because the breath pulsates or is transmitted there ("*nishmato dofeket sham*").

In mustering further support for his position, the Ḥakham Zevi quotes a series of sources from the Middle Ages including Ibn Ezra, Kuzari⁷⁷ *Sha'ar ha-Shamayim* and *Shevilei Emunah*.⁷⁸ The quotes from these authors all discuss variations on the theme of "innate heat" (*ḥom ha-tiv'i*). Without a fundamental understanding of the contemporaneous notions of cardio-respiratory physiology, these passages can easily be misinterpreted. The heart was thought to contain the source of the body's heat and this "innate heat" was thought to be the source of life. (See my discussion of Greek physiology, above

#3.) The purpose of respiration was to cool the flames of the heart, and the inability to cool these flames would lead to excess heat and, ultimately, to death. The notion of the "innate heat" of the heart was only disproved in the seventeenth century by Giovanni Alfonso Borelli when he actually measured the temperature of the heart with a thermometer.⁷⁹

In sum, the Ḥakham Zevi subscribes to the Aristotelian ideas of the embryological and physiological significance of the heart. His physiological discussion is largely consistent with accepted medical teachings of his time, except for the omission of the notion of the circulation of the blood. In addition, his proofs are firmly rooted in theories of Greco-Roman and Renaissance medicine.

R. Yonatan Eybeschutz also addressed the question of the heartless chicken and took issue with the decision of the Ḥakham Zevi.⁸⁰ Whereas the Ḥakham Zevi quoted older sources discussing medical theory, R. Eybeschutz wished to settle the matter by sending a letter to the medical faculty of the University of Halle in Germany. The question he posed to the physicians was whether an animal could live without a heart or some other organ serving a similar function. He quotes their response verbatim in his work. He also stresses that the discussion of the Ḥakham Zevi is based on medical theories which often change with time:

Regarding scientific principles based on experimentation, today the hypothesis is one way, and when others observe the opposite phenomenon, they retract the initial hypothesis and replace it with another. And such is always the case. Even now, based on experimentation, [scientists] have actually retracted all the assumptions and conclusions of Galen and Aristotle.⁸¹

In addition, R. Eybeschutz notes that while certain aspects of Jewish law have a specific *mesorah*, such as which animals are considered a *trefah*,⁸² there is no such *mesorah* for the understanding of the function of the heart. This is perhaps why he felt free to consult contemporary physicians as opposed to quoting from earlier rabbinic sources.

Post-Mortem Caesarean Section and the Passage in Tractate *Erkhin*

A recent medico-legal case in Israel involving a pregnant brain dead woman has led the brain death controversy into another area of interface between rabbinic and medical knowledge. The question presented before an Israeli court was whether a caesarean section could

or should be performed on a brain dead woman in order to deliver the fetus. Although the court decided, as per the husband's wishes, that a caesarian section not be performed, the case sparked discussion amongst halakhic authorities as to the permissibility of performing such a procedure.⁸³

The Talmud (*Erkhin* 7a) states that if a pregnant woman dies a natural death, the fetus dies first, but if she is killed (i.e. a traumatic death), the fetus outlives the mother. If the aforementioned brain dead woman was halakhically dead, and died a natural death, how is it possible for her to give birth to a live child? This would seemingly run counter to the teaching of the Talmud that states that the fetus dies first in such a case.

In addition, the Talmud seems to contradict itself. A later passage, in the name of Samuel, states that if a woman dies during labor on the Sabbath, one can carry a knife through a public domain, cut open her abdomen, and remove the child. Once again, if the fetus cannot outlive the mother, why should it be permissible to violate the Sabbath to attempt to remove it?

Both above contradictions can be resolved if one assumes that the statement of the Talmud that the fetus dies first in a natural death was not categorical, but rather only meant to describe the majority of cases.⁸⁴ These two circumstances, therefore, can be understood as representing the minority. Alternatively, the Talmud's statement may be categorical, but both of the above cases represent circumstances not addressed by it. In the contemporary legal case, the mother was receiving artificial respiration, a circumstance not accounted for in the talmudic statement.⁸⁵ And in the Talmud's own case regarding carrying the knife on Shabbat, if the woman is in labor, the child may have already begun to exert his physiological independence. As a result, in such a case, the child may outlive the mother.⁸⁶ Whatever the case may be, I concern myself here only with the medical historical aspects of a caesarean section.

In addition to this passage, there are multiple passages in Tractates *Niddah* and *Bekhorot* which discuss both live and post-mortem caesarean section for both humans and animals.⁸⁷ These passages have fueled multiple debates in the medical historical literature regarding the antiquity of caesarean section with maternal survival.⁸⁸ Do the passages that discuss live caesarean section (i.e. caesarian section with maternal survival) reflect actual cases or simply theoretical constructs? While the answer to this question is entirely irrelevant to the halakhist, the medical historian has found the question irresistible. Post-mortem caesarian section is well documented from before the common era, but the performance of caesarean section with maternal

survival is not believed to have occurred before the Middle Ages.⁸⁹ The references to live caesarian section in talmudic times, if actual occurrences, would obviously supplant this notion.

A comment should also be made regarding post-mortem caesarian section. As we have stated, according to the talmudic passage in 'Erkbin, if a pregnant woman dies of natural causes, the fetus dies first. Such is not the case, however, for a traumatic death of a pregnant woman. There is extensive literature on post-mortem caesarean section which dates back to Roman antiquity. Indeed, laws were instituted in the Roman Empire requiring the opening of dead bodies of pregnant women shortly after death.⁹⁰ Since these laws were perpetuated and publicized in the times of Caesar, the procedure became known as a caesarean section.⁹¹ It seems obvious that there must have been at least a small percentage of fetal survival; otherwise, the procedure would not have been mandated. Do these cases contradict the Talmud? Unfortunately, it is impossible to know whether the cases of fetal survival were associated with the natural or traumatic death of the mother. In addition, some authorities claim that it is possible for the fetus to survive in a minority of cases, as stated above.

As recently as the late nineteenth century, there are multiple references in the medical literature to the delivery of live infants after post-mortem caesarean section. Infant survival was even documented after a child was extracted as much as two hours after the death of its mother.⁹² Again, there is no differentiation in this medical literature between natural and traumatic death of the mother. It is also possible that the determination of death was inaccurate and, in fact, the mothers were not dead, neither according to halakhic criteria, however one wishes to define them, nor according to contemporary medical standards. To quote contemporary medical literature about post-mortem caesarean section is irrelevant as the intervention of artificial respiration eliminates the equation of these cases to those of the Talmud.⁹³

While the practice of post-mortem caesarean section was universally accepted in the secular world throughout history, it seems that such was not always the case in the Jewish world. As early as the period of the Geonim there was a ban placed on performing post-mortem caesarean sections.⁹⁴ This ban was continued by the author of the *Issur ve-Heter*⁹⁵ and reiterated by R. Moshe Isserles.⁹⁶ The reason invoked by the latter two authorities is that "we are not qualified" to determine the death of the mother.⁹⁷ Since one must wait a significant period of time before declaring her death, a caesarean section is no longer indicated. By that time the fetus would surely have died.

Today, however, given our enhanced ability to both determine the death of the mother, cardiac death as well as brain death, and sustain the life of the fetus, some authorities would allow a post-mortem caesarean section.⁹⁸

Conclusion

I have provided a medical historical overview and analysis of some of the rabbinic sources quoted in contemporary discussions of brain death, a current issue in the world of medical halakhah. Understanding the scientific theories contemporary with the rabbinic positions expressed enables us to appreciate their medical frame of reference, their allusions to medical theory and their quotations of prominent figures in the history of science. In addition, otherwise cryptic rabbinic passages can be clarified.

In a rapidly progressing field, such as twentieth century medical halakhah, the understanding of the latest medical theories and treatments is crucial to be an effective *posek*. By the same token, Rabbis of all generations had to be knowledgeable about the state of medicine in their age in order to render an appropriate *pesak*. An awareness of the state of medicine co-existing with particular rabbinic figures can enhance our understanding of the medical and halakhic issues with which these Rabbis were dealing. This knowledge can perhaps assist current *posekim* in their utilization of rabbinic source material for incorporation into medical halakhic discussions.

Notes

1. According to the Hazon Ish, the halakhah with respect to *trefot* was established based on the medical knowledge of the rabbis of the Talmud. Therefore, even if our medical understanding should change, we are legally bound by the decision of our predecessors. See *Hazon Ish, Yoreh De'ab* 5:3; *Hil. Nashim* 27:3. R. Herschel Schachter applies this principle to the determination of death as well, and claims that we should be bound by how the Rabbis of the Talmud defined death. See his "Bi-Dinei Met ve-Gavra Ketilla", *Bet Yitzhak* 21 (1989): 121. This is a legal principle, yet it impacts on the value of studying medical history. While changes in medical understanding may be acknowledged throughout history, they bear little relevance to the process of deciding halakhah. According to this position, therefore, the content of this article is purely academic.
2. See, for example, the articles by Marshall Kielson, Fred Rosner, R. Moshe Tendler, R. Herschel Schachter, R. Ahron Soloveichik, and Chaim Dov Zweibel, "Determining the Time of Death," in the *Journal of Halacha and Contemporary Society* 17 (Spring, 1989): 7-49; R. Moshe Tendler, "Halachic Death Means Brain Death," *Jewish Review* 3:3 (January-February, 1990): 7; R. J. David Bleich, *The Time of Death in Jewish Law* (Union City, 1991); Fred Rosner, "The Definition of Death,"

- Modern Medicine and Jewish Ethics* (New York, 1991), 263-78; Chaim Dov Zweibel, "A Matter of Life and Death-Revisited," *Jewish Observer* 24:7 (October, 1991): 11-22; Yitzchak Breitowitz, "The Brain Death Controversy in Jewish Law," *Jewish Action* 52:2 (Spring, 1992): 61-66.
3. See Samuel Weiss, "Ke'at Rega ba-Mavet be-Refuab u-ve-Halakhab" (M.D. thesis; The Hebrew University/Hadassah Medical School; July, 1983), 1-4 for biblical descriptions of death.
 4. John A. Parashos, "Biblical Accounts of Resuscitation," *Journal of the History of Medicine* 47 (July, 1992): 310-21. See also Abraham S. Abraham, "Hanshamah Melakhutit be-Tanakh," *ba-Ma'ayan* 28:3 (1988): 72-76.
 5. For some of the major works which deal exclusively with this topic, see M. Perlman, *Midrash ba-Refuab* (Tel Aviv, 1926); Y.L. Katznelsohn, *ba-Talmud ve-Hokmat ba-Refuab* (Berlin, 1928); J. Snowman, *A Short History of Talmudic Medicine* (London, 1933); Charles Brim, *Medicine in the Bible* (New York, 1936); Solomon Kagan, "Talmudic Medicine," *Medical Leaves* 3:1 (1940): 164-73; Maurice Bear Gordon, "Medicine Among the Ancient Hebrews," *Isis* 33 (1941): 454-85; Benjamin Lee Gordon, "Ancient Hebrew Medicine," in his *Medicine Throughout Antiquity* (Philadelphia, 1949), 251-94; Jacob Glenn, *The Bible and Modern Medicine* (New York, 1959); Edward Neufeld, "Hygiene Conditions in Ancient Israel," *Journal of the History of Medicine and Allied Sciences* 35:4 (October 1970): 414-37; Fred Rosner, *Medicine in the Bible and the Talmud* (New York, 1977); Julius Preuss, *Biblical and Talmudic Medicine* (New York, 1978).
 6. For previous studies on the interface between talmudic and Greco-Roman medicine see, for example, Stephen Newmyer, "The Concept of Climate and National Superiority in the Talmud and its Classical Parallels," *Transactions and Studies of the College of Physicians of Philadelphia*, Medicine and History Series 5:1 (March, 1983): 1-12; *idem.*, "Talmudic Medicine and Greek Sources," *Koroth* 9:1-2 (1985): 34-57; *idem.*, "Talmudic Medicine: A Classicist's Perspective," *Judatim* 29 (1980): 360-67; J. Preuss, *op.cit.* (n.5).
- For information regarding the familiarity of Greek authors with Jews and Jewish medicine see, for example, R. Walzer, *Galen on Jews and Christians* (Oxford, 1949); Menachem Stern, *Greek and Latin Authors on Jews and Judaism* (Jerusalem, 1980), 307-28.
- For evidence that the Jews of the Middle Ages and Renaissance were familiar with Galen, see Elinor Lieber, "Galen in Hebrew" in *Galen: Problems and Prospects*, ed. Vivian Nuttun (London, 1981), 167-86.
7. The earliest Hebrew medical manuscript is generally believed to be that of the "Book of Remedies" attributed to Asaph the physician. Regarding the dating of Asaph, see Sussman Muntner, "The Antiquity of Asaph the Physician and His Editorship of the Earliest Hebrew Book of Medicine," *Bulletin of the History of Medicine* 25 (1951): 101-31; Elinor Lieber, "Asaf's Book of Medicines: A Hebrew Encyclopedia of Greek and Jewish Medicine, Possibly Compiled in Byzantium on an Indian Model," *Dumbarton Oaks Paper* 38 (1984): 233-49; Joseph Shatzmiller, "Doctors and Medical Practices in Germany Around the Year 1200: The Evidence of Sefer Asaph," *Proceedings of the American Academy for Jewish Research* 50 (1983): 149-64; Stephen T. Newmyer, "Asaph's 'Book of Remedies': Greek Science and Jewish Apologetics," *Sudboff's Archiv* 76:1 (1992): 28-36.
- However, Professor James Charlesworth has recently published the translation of a small medical fragment discovered amongst the Dead Sea Scrolls, which dates back to pre-Mishnaic times. See J.H. Charlesworth, *The Discovery of a Dead Sea Scroll (4Q Theropetia): Its Importance in the History of Medicine and Jewish Research* (Lubbock, Texas, 1985).
8. See E. Lieber, *op. cit.* (n. 6). Galen is quoted extensively by Asaph, by Maimonides in the twelfth century, and by Tobias Cohn in the eighteenth century.
 9. See Everett Mendelsohn, *Heat and Life: The Development of the Theory of Animal Heat* (Cambridge, 1964), 17.

10. The terms Galenic medicine and Greco-Roman medicine are used here interchangeably. Galen's theories are largely derived from and are variations on the ideas of his predecessors, primarily Hippocrates, Empedocles, Aristotle and Erasistratus. Some major differences between them exist and they will be noted as relevant to our topic. Generally speaking, however, Galen was the last and perhaps the greatest of the Greek men of medicine, and his works represent the culmination of Greco-Roman medicine and physiology. See George Sarton, *Galen of Pergamon* (Lawrence, Kansas, 1954).
 11. The doctrine of the four humors is as old as Empedocles (500-430 B.C.E.), but Galen refined the doctrine by also incorporating the ideas of Hippocrates (b. 460 B.C.E.) and Aristotle (384-322 B.C.E.). See Margaret Tallmudge May, *Galen: On the Usefulness of the Parts of the Body* (Ithaca, 1968), 44-45, and n. 191.
- Whether the rabbis of the Talmud accepted the doctrine of the four humors is a matter of debate. Some talmudic passages can be interpreted in light of this doctrine. It is clear, however, that later Jewish authors did accept it. See H.J. Zimmels, *Magicians, Theologians and Doctors* (London, 1952), 78-80; 217, n.5; 219, n.13.
12. See May, 45. The concept of the soul or a soul being associated with an organ or limb is found in Jewish sources. The phrase used is "ever she-ba-neshamah telyah bo." See *Enzyklopedie Talmudt* I (1990), 109. Following Galen, Maimonides states that the organs associated with the soul are the heart, brain and liver. R. Herschel Schachter's article on the definition of death, *op. cit.* (n. 1), is based on this notion.
 13. See E. Mendelsohn, *op. cit.* (n. 9), 8. The idea of innate animal heat continued in different forms into the late eighteenth century. See Max Neuburger, *The Historical Development of Experimental Brain and Spinal Cord Physiology Before Flourens* (Baltimore, 1981), 231-36. The belief that the heart had a higher temperature than the rest of the body persisted until the seventeenth century when Giovanni Alfonso Borelli disproved it with the use of a thermometer. See May, 53, n. 231.
 14. See May, 50-53; Mendelsohn, 17-22. The principle of innate heat was accepted by rabbinic scholars as well. See the sources quoted by Hakham Zevi, cited below.
 15. This idea originated with Hippocrates and Aristotle. See May, 51 and Mendelsohn, 20-21. See also David J. Furley and J.S. Wilkie, *Galen on Respiration and the Arteries* (Princeton, 1984), 14-17. Oxygen was only discovered in 1771 by Joseph Priestley. See Fielding Garrison, *History of Medicine* (Philadelphia, 1960), 328-30.
 16. The exact anatomical pathway of the air was believed to be as follows: "It enters the body through the windpipe or trachea and so passes to the lung and thence, through the 'arteria venalis'—which we call the pulmonary vein—to the left ventricle of the heart, where it encounters the blood." See Charles Singer, *A Short History of Medicine* (Oxford, 1928), 56.
 17. The pneuma travels from the heart to the brain via the carotid arteries. However, according to Galen, before the carotid arteries bring the blood to the brain, they divide at the base of the brain to form a marvelous network of vessels. This so-called "rete mirabile" is found in ungulates but not in man, and is one of the gross errors in human anatomy that was perpetuated by Galenic teachings. See May, 47; Henry Karplus, "Cooling of the Blood and the Rete Mirabile Herophilus," *Koroth* 8: 9-10 (August 1984): 436-40; Charles Singer, "Some Galenic and Animal Sources of Vesalius," *Journal of the History of Medicine and Allied Sciences* 1:1 (January 1946): 18-19.
 18. As to the pathway the air takes to reach the heart, see above n. 16. Galen believed that the inspired air could not proceed directly to the heart for distribution to the whole body. It was required to undergo preliminary preparation before becoming the vital spirit. See May, 47.
 19. See Furley and Wilkie, 17-18.
 20. See Furley and Wilkie, 17-20, n. 17. For a comprehensive study of ancient Greek notions of cardiovascular physiology, see C.R.S. Harris, *The Heart and the Vascular System in Ancient Greek Medicine* (Oxford, 1973).
 21. Galen designed an intelligent experiment to ascertain the function of the brain and

- spinal cord. After dissecting the spinal cords of animals at different levels, he observed the attendant neurological deficits. When he cut the section between the skull and the first vertebra, the animal was deprived of sensation, respiration and motion. See W.L.H. Duckworth, *Galen on Anatomical Procedures: The Later Books* (Cambridge, 1962), 17-26. For Hippocrates' view of the brain, see G.E.R. Lloyd, ed., *Hippocratic Writings* (New York, 1978), "On the Sacred Disease," esp. 249-51.
22. See Charles Singer, trans., *Galen on Anatomical Procedures* (London, 1956), 181-84.
 23. Although the discovery of the systemic circulation of the blood is generally attributed to Harvey, the pulmonary circulation was recognized much earlier. See M. Meyerhoff, "Ibn An-Nafis (13th century) and his Theory of the Lesser Circulation," *Isis* 23 (1935): 100-20; L.G. Wilson, "The Problem of the Discovery of the Pulmonary Circulation," *Journal of the History of Medicine* 17 (April 1962): 229-44.
Some scholars have claimed that the idea of the circulation of the blood appears in Hebrew sources that antedate Harvey. See David Margalit, "Nizanei ha-Ra'ayon 'al Maḥzor ha-Dam bi-Mekorotenu ha-'Atikim," *ba-Rofe ha-'Ivrit* 2 (1957): 79-88; Joshua Leibowitz, "Smukhim Harveyaniyim bi-Refu'ah ha-'Ivrit," *idem.*, 74-79; E. Lieber, "A Medieval Hebrew Presage of the Circulation of the Blood, Based on Biblical and Talmudic Concepts," *Koroth* 9:1-2 (1985): 157-63.
 24. The term "vessel" refers to both arteries and veins. The anatomical difference between them was known before Galen's time, but the functional difference was not. The valves of the veins were described by Fabricius of Aquapendente (16th century), and the connection between the arteries and veins, i.e., the capillaries, was first described by Marcello Malpighi (17th century). See Garrison, 222-23, 255-56.
 25. See Charles Singer, trans., "Against the View that Arteries are Empty," *Galen on Anatomical Procedures* (London, 1956), 197-200. However, this does not preclude the notion that the arteries contained pneuma as well. See Rupert Hall, "Studies on the History of the Cardiovascular System," *Bulletin of the History of Medicine* 34 (1960): 391-413, esp. 410.
 26. Some have interpreted a talmudic passage based on the debate as to whether arteries contain air or blood. According to Rav (*Hullin* 45b), even a small perforation of the aorta ("kaneb ha-lev") is considered a *trefab*, whereas according to Shmuel, a larger tear is required. See J. Preuss, 103; David Margalit, "Pirkei Anatomia Lifnim bi-Yisrael ve-Hayom," *Koroth* 1: 11-12 (June-July, 1957): 379-80.
 27. See A.L. Peck, trans., *Aristotle: The Generation of Animals* (Cambridge, 1953), 193.
 28. This was the position of Lactantius of Nicomedia (325 C.E.). See J. Needham, *A History of Embryology* (New York, 1959), 78.
 29. This was the position of Alcmaeon (sixth century B.C.E.). See Needham, *ibid.*
 30. For an overview of the history of embryology, see J. Needham, *op. cit.* (n. 28); Howard Adelmann, "A Brief Sketch of the History of Embryology before Fabricius," in his trans. of *The Embryological Treatises of Hieronymus Fabricius of Aquapendente* (Ithaca, 1967), 1, 36-70. For references to embryology in Jewish sources, see Samuel Kottek, "Embryology in Talmudic and Midrashic Literature," *Journal of the History of Biology* 14:2 (Fall 1981): 299-315; David I. Macht, "Embryology and Obstetrics in Ancient Hebrew Literature," *Johns Hopkins Hospital Bulletin* 22: 242 (May, 1911): 1-8; W.M. Feldman, "Ancient Jewish Eugenics," *Medical Leaves* 2 (1939): 28-37; D. Schapiro, *Obstetrique des Anciens Hebreus* (Paris, 1904); W.M. Feldman, *The Jewish Child* (London, 1917), 120-44; H.J. Zimmels, *Magicians, Theologians and Doctors*, 62-64; Needham, 77-82; J. Preuss, 41-138.
 31. The apex beat is usually palpable on the left anterior chest in the fifth intercostal space. See G.E.R. Lloyd, ed., *Hippocratic Writings*, 348.
 32. *Ibid.*, 31. Herophilus, a student of Praxagorus, developed a complex system of measuring the pulse based on musical rhythms. Because of the intricacy of this method, it could not be applied in clinical medical practice. See Karl Zurbach, "Early Ideas and Theories on the Motion of the Blood," *Ciba Symposium* (1939): 71-77, esp. 71-72.
 33. See Logan Clandening, *Sourcebook of Medical History* (New York, 1960), 42-45. Asaph the Physician also discusses the value of palpating the peripheral pulses. See, for example, the Hebrew manuscript from the British Library Oriental Collection, Add. 27, 018. For information on Asaph, see above, n. 7. This section of Asaph is likely borrowed from Galen.
 34. The two phrases *bi-bu di-hava kayyam* and *bi-bu di-hava ribon* are subject to interpretation. I have provided a loose translation.
 35. There is an allusion to palpation of the pulse in *Midrash Tehillim* 73:1, quoted by Preuss, 143.
 36. The *Korban ha-'Edab* on *Talmud Yerushalmi*, *Yoma* 8:5 cites the scriptural verse, "all in whose nostrils was the breath of life" (*Beresheet* 7:22), as does the *Talmud Bavli* discussed below.
 37. See *Korban ha-'Edab*, *loc. cit.*
 38. For that position, see J. Needham, 78.
 39. The '*En Ya'akov* 2 (Jerusalem, 1961), 37a actually juxtaposes the two passages from *Yoma* and *Sotah*. Cf. *Niddah* 25b where Abba Shaul maintains that the head is formed first, a seeming contradiction to his position in *Sotah*.
 40. For the issue of the integration of scientific knowledge into halakhah, and the conflict between the opinion of the Sages and that of modern science see, for example, Abraham S. Abraham, *Nishmat Avraham: Orat Hayyim* (Jerusalem, 1984), 77-81, n. 20; Dov I. Frimer, "Establishing Paternity in Jewish Law," *Proceedings of the Association of Orthodox Jewish Scientists* 8-9 (1987): 159 and 186-87. (I thank Dr. David Shatz for directing me to this source); H. Schachter, *op.cit.* (n.1), 121-22; Yaakov Neuberger, "Halacha and Scientific Method," *The Torah u-Madda Journal* 3 (1991-1992): 82-89; Marc D. Angel, "Authority and Dissent," *Tradition* 25:2 (Winter 1990): 18-26, esp. pp. 22-26; *She'elot u-Teshuvot Hatam Sofer*, *Yoreh De'ab* # 338; *Hazon Ish*, *Nashim* (Bnei Brak, 1991), *Hil. Isbut* 27:3. The methodology of this paper does beg a thorough analysis of this issue, which I hope to address in another forum.
 41. Translation by Leo Jung, *Soncino Talmud* (London, 1984).
 42. The Rif, Ran and Rosh all preserve the text of the *Talmud Yerushalmi* of " 'ad tiburo'. The Meiri says, "tiburo o lev'.
 43. See above regarding the passage from *Sotah* 45a.
 44. Rashi, *Yoma* 85a, s.v. *bakbi garsiman*.
 45. *Kerit* 22a: *יציאה פירוש שרץ וצאה בשעה שחנטקה* "יציאה פירוש שרץ וצאה בשעה שחנטקה" *misrafsarif*: *מושרך הרם פבית השחטה* "וכנס בלב" and Rashi, *ad loc.*, s.v. *מושרך הרם פבית השחטה*.
 46. Rashi, *ad loc.*, s.v. *tlata kanet*.
 47. Admittedly, this Rashi and the ones later mentioned refer to animal anatomy. However, it is unlikely that so fundamental an anatomical notion should vary, according to Rashi, between humans and animals. Indeed, Tosafot (*Hullin* 42b, s.v. *ve-amer*) states regarding *trefot* that one should differentiate between man and animal, but only in matters where their anatomy differs. The Talmud, however, does explicitly prohibit the extrapolation from animal to human anatomy. See *Hullin* 68a, "*adam me-behemah lo yalif*" and *Tosafot*, *ad loc.*, s.v. *shilya*.
As human dissection was frowned upon during most of antiquity, the great scientists almost uniformly extrapolated from animal anatomy. Aristotle states that the inner parts of the body are unknown, especially those of man; consequently, one must refer to the parts of animals which have a nature similar to the nature humans possess, and examine them. See Jonathan Barnes, ed., *Complete Works of Aristotle* (Princeton, 1985), 788.
 48. Galen is notorious for having extrapolated his anatomy from animals, and this led to many erroneous conclusions. See, for example, Charles Singer, "Some Galenic and Animal Sources of Vesalius," *op. cit.* (n. 17), 6-24.
 49. In *Hullin* 49a, the Talmud discusses a case where a needle was found in the large vessel of the liver of an animal and presents a debate as to whether or not it is kosher. Rashi, however, addresses the question of how the needle reached its loca-

tion. In doing so, he details the relevant anatomy and concludes that the needle must have been ingested by way of the trachea. It reached the large vessel of the liver by passing through the branch of the trachea that leads to the liver. In passing, Rashi also mentions the branches of the trachea that lead to the heart and lungs.

Another such example appears in *Hullin* 111a. In the context of a discussion on the necessary preparations for eating liver, the Talmud mentions a case where a particular dish was brought before Yanai, the son of Rebbe Ami. The dish was called *kanya bi-kufyab* and Rashi explains it to consist of the trachea and all that is attached to it, namely the lung, heart and liver. All these organs were cooked together. For reasons related to that passage, the Talmud constructs a scenario whereby the blood of the liver can flow directly out of the pot and not be cooked with the other organs. In explaining this unique circumstance, Rashi (s.v. *dilma*) elaborates on the anatomy of these organs and postulates a pathway for the blood. He states, "The small vessels of the liver drain into the tube [*kaneb*] of the lung (i.e., trachea). From here the blood traverses through the hollow [of the trachea] to the outside of the pot." Here, again, it is quite clear that Rashi believed that the three major organs, including the heart, are directly connected to the trachea.

49. Preuss, 103, claims that this position of Rashi's is consistent with the teaching of Aristotle. I have been unable to verify this assertion. Aristotle believed that the air ultimately reached the heart, but it is unclear whether he believed that the trachea connected directly to it. Leonardo Da Vinci postulated a more direct route for the air to reach the heart than did Galen, but it was not as direct as it would be according to Rashi. See J. Playfair McMurrich, *Leonardo Da Vinci: The Anatomist* (Baltimore, 1930), 195. Da Vinci obviously post-dates Rashi by some 400 years.
50. There are no clearly documented human dissections from the time of Rashi, although scattered references to autopsies and dissections appear in the thirteenth and fourteenth centuries. Mundinus (1270-1326) is recognized to have been the first to incorporate human anatomical dissection into the medical curriculum. See, for example, C.D. O'Malley, *Andreas Vesalius of Brussels* (Berkeley, 1964), 1-20; Ludwig Edelstein, "The History of Anatomy in Antiquity," in *Ancient Medicine* (Baltimore, 1967), 247-302; Charles Singer, *A Short History of Anatomy and Physiology From the Greeks to Harvey* (New York, 1957); Mary Niven Alston, "The Attitude of the Church Towards Dissection Before 1500," *Bulletin of the History of Medicine* 16:3 (October 1944): 221-38; Nancy Siraisi, *Taddeo Alderotti and His Pupils* (Princeton, 1981), 66-69. I have extensively researched the history and halakhah of anatomical dissection and would welcome any inquiry about this topic.
51. Regarding Rashi's relationship with a Jewish physician named Meshulam, and regarding his general medical knowledge, see John R.W. Dunbar, trans., *History of the Jewish Physicians from the French of E. Carmoly* (Baltimore, 1845), 42-43. Note, however, that Carmoly quotes no sources. The veracity of his assertions is in question, and I have seen no other source that corroborates his claims.
52. See his *Paḥad Yitzḥak* 10 (Bnei Brak, 1980), 53-54, s.v. *telata kant*. R. Lampronti was himself a physician who graduated from the University of Padua. See Abdalkader Modena, *Medici E Chirurghi Ebrei Dottorati E. Licenzati Nell Università Di Padova Dal 1617 al 1816* (Bologna, 1967), 55-57.
It is worth quoting Rabbi Lampronti's critique of Rashi:
"I, the young author, question the position of Rashi. For it appears that he believed that the trachea enters into the liver and heart. Any scholar with knowledge of anatomy can see with his own eyes . . . that this is not."
Y.L. Katznelsohn makes a similar comment in his book, *ba-Talmud ve-Hokmat ha-Refu'ab* (Berlin, 1928), 131. He defends Rashi by claiming that this statement must have been inserted by a student of Rashi, as Rashi knew too much about anatomy to make such a gross error. David Margalit likewise defends Rashi against R. Lampronti and claims that Rashi was actually referring to the major heart

vessels, i.e. the aorta, etc. See his "Erkhim Refu'im she-bi-Enzyklopedia ha-Hilkhatit 'Paḥad Yitzḥak' le-R.Y. Lampronti," *Koroth* 2: 1-2 (April 1958): 59.

In my humble opinion, however, had Dr. Katznelsohn and D. Margalit seen the other two passages of Rashi in *Hullin* (see above, n. 48), it is doubtful whether they still could have maintained their defenses.

53. I refer here to the terms used in Mishnah, *Niddab* 2:5. For further discussion about the identification of these terms, see, for example, Preuss, 115-19; Abraham Abraham, *Nishmat Avraham, Yoreh De'ab*, 76-79; I.M. Levinger, "Ha-Mivneh ha-Anatomi shel Evarei ha-Min bi-Ishah u-ve-Ba'alei Ḥayyim," *Koroth* 4: 8-10 (June 1968): 611-15; Tirzah Z. Meachum, "Mishna Tractate Nidda with Introduction: A Critical Edition with Notes on Variants, Commentary, Redaction and Chapters in Legal History and Relia," (unpublished doctoral dissertation; Hebrew University, 1989), 224-31. I am currently working on an explanation of the terms of the Mishnah based on the anatomical teachings of Herophilus.
54. Even the Rambam's anatomical description is difficult to understand today. He discusses this matter extensively in his *Commentary on the Mishnah, Niddab* 2:5, and, more succinctly, in his *Mishneh Torah, Hil. Issurei Bi'ab*, Chapter 5. It is difficult to identify the structure called the "lul" according to the interpretation of the Rambam.
55. See *She'elot u-Teshuvot Ḥatam Sofer, Yoreh De'ab*, # 167.
56. A small excerpt of this passage was quoted by F. Rosner and M. Tendler, *op. cit.* (n. 2), but I believe the full quotation will be more revealing and is highly relevant to the methodology and content of this article.
57. See May, *op. cit.* (n. 11), 58. This is the position of Galen. See also Adelman, *op. cit.* (n. 30), 41, 43.
58. May and Adelman, *ibid.*
59. For discussion on the importance of the evacuation of the phlegm, one of the four humors, from the brain, see Lloyd, *Hippocratic Writings, op. cit.* (n. 21), 241-47. For a discussion on the anatomy and physiology of the canal that connects the brain to the nostrils, see May, *op. cit.* (n. 11), 428-30.
60. The Rambam, in his medical aphorisms, mentions that the brain undergoes constant pulsatile motion which contributes to the expulsion of waste from the brain. See F. Rosner, *Maimonides' Medical Writings: The Medical Aphorisms of Moses Maimonides* (Haifa, 1989), 14-15.
61. Most contemporary halakhic sources have viewed the checking of the nostrils as a means of assessing respiration but not necessarily specific organ function; the issue being whether the absence of respiration itself is a sign or a definition of death. Rabbi Modena, however, views the checking of the nostrils to be a direct assessment of brain function.
62. Although Rabbi Modena, himself, had no formal medical training, he was friendly with a number of medical students at the nearby University of Padua. See Howard E. Adelman, "Leon Modena: The Autobiography and the Man," in *The Autobiography of a Seventeenth-Century Venetian Rabbi*, trans. and ed. by Mark R. Cohen (Princeton, 1988), 30, and n. 76.
63. See the articles by M. Tendler, above, n.2.
64. The assumption is that the latter half of the *Mishnah* ("If they are decapitated...") refers to man as well as animals. This appears to be the opinion of the Rambam (*Hil. Tum'at Met* 1:15). According to the *Gilyon ha-Rosh* on the *Mishnah* in *Obalot*, however, both Rashi and Tosafot in *Hullin* maintain that this phrase excludes man. The *Ḥidushei Rashash* on *Obalot* adjusts the text of Tosafot to include man. See also *Tiferet Yisrael, ad loc.*
65. Rambam, *Commentary on Mishnah, Obalot, ad loc.*
66. In the Rambam's medical writings, there are virtually no references to religious or halakhic matters, and, in general, rabbinic authorities do not consult them at all. In this discussion, however, I believe a deviation from the norm is indicated, as will be self-evident.

67. See F. Rosner, *op. cit.* (n. 60), 446, treatise # 25, item # 70. This last of the Rambam's treatises in the aphorisms is devoted exclusively to criticism of Galen. This item, # 70, as well as the following two items, deal extensively with the issue of whether the heart or brain is the source of movement, and the Rambam here, as in the remainder of this treatise, severely criticizes Galen's view. These items comprise the concluding section of the book of aphorisms, which may reflect their relative significance.

Although the Rambam believes the heart to be the primary organ providing the power or energy which ultimately is responsible for movement, he clearly acknowledges a major role of the brain in movement. See *ibid.*, 16.

Regarding the Rambam's view of the heart, see also Rambam's *Guide* 1: 38, 72. Regarding the Rambam's criticism of Galen, see Max Meyerhoff, "Maimonides Criticizes Galen," *Medical Leaves* 3:1 (1940): 141-46.

68. See H.Y.D. Azulai, *Shem ba-Gedolim* (Jerusalem, 1954), "Sba'ar ba-Shamayim," 68b. This work is largely a compilation of other sources and apparently includes excerpts from the Rambam's *Sefer ha-Nefesh*. The Hakhm Zevi disputes this latter notion. See *She'elot u-Teshuvot Hakhm Zevi*, # 77.

69. Rabbenu Gershon makes no reference here to the *Mishnah* in *Ohalot*, but if we applied the position of Aristotle to the *Mishnah*, then a decapitated man or animal, if it is moving, should still be considered alive and should not spread impurity.

70. See C. Singer, *Galen: On Anatomical Procedures*, *op. cit.* (n. 25), 184.

71. See Samuel W. Lambert, trans., *Andreas Vesalius: De Fabrica Corporis Humanis* in L. Clandening, *Source Book of Medical History*, *op. cit.* (n. 33), 149.

72. See Gweneth Whitteridge, trans., *William Harvey, Disputations Touching the Generation of Animals* (Oxford, 1981), 243.

73. See sources quoted in H.J. Zimmels, *op. cit.* (n. 11), 39-41, 196-97. See *Shulhan 'Arukh, Yoreh De'ab*, 40:5. The question the later rabbinic authorities address is if an animal cannot survive at all without a heart, then such an animal should be considered a *nevelah* and not a *trefah*.

74. *She'elot u-Teshuvot Hakhm Zevi*, # 77.

75. Harvey's famous work, *De Motu Cordis*, first appeared in 1628. However, Harvey earlier alluded to the idea of systemic circulation in his lectures on anatomy. See C.D. O'Malley, *et al*, annotated translation, *William Harvey: Lectures on the Whole of Anatomy* (Berkeley, 1961), 191-92.

Although Harvey's work appeared in 1628, it is not clear when his notions of circulation became universally accepted by the medical world. On the Spanish neglect of Harvey's *De Motu Cordis*, see J.J. Izquierdo, "On Spanish Neglect of Harvey's 'De Motu Cordis' for Three Centuries, and How it was Finally Made Known to Spain and Spanish Speaking countries," *Journal of the History of Medicine* (Winter 1948): 105-24.

76. Since the term "*nesbamab*" can be translated as either "soul" or "breath", I preserve the original Hebrew. I believe it is clear from later in the passage, however, that it refers to "breath".

77. 2:26. In this passage, Yehudah Halevi likens the innate heat in the heart to a flame on a candle wick. This candle analogy is strikingly similar to that mentioned by Galen. See May, *op. cit.* (n. 11), 52. See also Y. Muscato, *Kol Yebudab*, commentary on Kuzari, *ad loc.*, which details the physiology of heat and pneumas.

78. This book was written by Meir ibn Aldabi, the grandson of R. Asher b. Yehiel, in 1360. It was reprinted many times, the last of which took place in Jerusalem, 1990. I was able to identify one of the Cairo Geniza fragments in Cambridge as being an excerpt from *Shevilei Emunah*. See Cairo Geniza fragment T-S NS 222.71 (folios 3-4) which is an excerpt from *Shevilei Emunah, netiv 5, shevil 7*.

79. See May, 53, and n. 231.

80. See his *Kretti u-Pleti, Yoreh De'ab*, 40:4.

81. Interestingly enough, R. Ya'akov Emden, the son of the Hakhm Zevi, also mentions the fact that the scientists of his times had rebelled against Aristotle and

Galen, a trend which he seems to view in a negative light. See his *Iggeret Bikoret* (Zhitomer, 1867), 47b. Hakhm Zevi himself did not mention this trend either because it had not yet taken place in his day or because he was not aware of it. Further research will be necessary to clarify this. Rav A.Y. Kook invokes the same idea about the changing nature of medical trends in his discussion about *mezizab* and the trustworthiness of doctors. See his *Da'at Koben* (Jerusalem, 1985), # 140.

82. See, for example, *She'elot u-Teshuvot ha-Rashba*, 1, # 98.
83. My thanks to Dr. Abraham Steinberg and Rabbi Yigal Shafran for clarifying the details of the case for me. Rabbi Shafran has compiled a medical ethics teaching manual based on this case. "*She'elah 'al Samkbut: ha-Im le-Yeled 'Ubar ba-Mazuy bi-Gufab shel Niflaret?*" (Jerusalem, 1991).
84. This is the position of Rashi, *ad loc.*, s.v. *u-mekarin*, "sometimes it occurs [in a natural death] that the mother dies first." See also sources quoted by the *Magen Avraham* commentary on *Shulhan 'Arukh, Orach Hayyim* 330:10.
85. To prove, in fact, that the statement of the Talmud does not apply to a case when the mother received artificial respiration, a sensational experiment was performed in 1992 involving the decapitation of a pregnant sheep and the subsequent birth, by caesarean section, of a healthy baby lamb. A video was taken of this experiment and it has been widely shown at medical halakhah conferences. The relevance and details of this experiment can be found in the halachic literature. See Abraham S. Abraham, *Nishmat Avraham* (Jerusalem, 1992), 175, addendum to *Yoreh De'ab* 339. See also Y. Shafran, *op. cit.* (n. 83).
86. A number of authorities maintain this position. See, for example, *She'elot u-Teshuvot ha-Radbaz*, # 695; the position of R. Isaac Stein quoted by Rabbi Moshe Isserles in his *She'elot u-Teshuvot ha-Rama*, # 40; *Ma'azait ha-Shekel* commentary to *Shulhan 'Arukh, Orach Hayyim* 330:10.
87. For these passages, see *Sefer ha-Tasbeez*, 1, # 10.
88. See J. Preuss, *op. cit.* (n. 5), 420-26; Jeffrey Boss, "The Antiquity of Caesarean Section with Maternal Survival: The Jewish Tradition," *Medical History* 5 (1961): 117-31. Boss provides an excellent discussion of the Jewish source material on this topic. See also Yehoshua Leibovitz, "Mavo Histori Refu'i le-Sefer Taharot," *Torah she-Ba'al Peh* 6 (1964): 33-39; *idem.*, "le-Toledot ha-Refu'ah bi-Sifrutenu," *Yauneh* 3:7-12 (1949): 187-89.
89. For general references on the history of caesarean section, see, for example, J.P. Boley, "The History of Caesarean Section," *Canadian Medical Association Journal* 145:4 (1991): 319-22; M. Pierce Rucker, "A Librarian Looks at Caesarean Section," *Bulletin of the History of Medicine* 25 (1951): 132-48 and references.
90. The first such law was instituted by Numa Pompilia in about 600 B.C. and was called the *Lex Regia*.
91. There is little historical foundation for the notion that Caesar, himself, was born by a so-called caesarian section.
92. See George M. Gould and Walter L. Pyle, *Anomalies and Curiosities of Medicine* (New York, 1896), 134-37.
93. In a recent case in England, a brain dead pregnant woman was maintained on artificial respiration and gave birth to a live baby. See "Critically Ill Girl Born After Mother is Killed," *The Independent* (September 7, 1992). In another recent case in Germany, an eighteen year old pregnant brain dead woman was maintained on a respirator in an effort to bring her pregnancy to a healthy birth. The woman ultimately miscarried and the respirator was disconnected, but the case fueled furious ethical debates. See "Brain Dead Woman Miscarries," *London Times* (November 22, 1992). An article appeared that week in the *London Jewish Chronicle* (November 27, 1992) regarding the Jewish view of this case entitled, "Why Not 'Play God'?" See also Rav. S.Z. Auerbach, *Minhat Shlomo* (Jerusalem, 1986), # 34, where he mentions that the laws of treatment of an eight-month fetus are different today because of the advent of the incubator.
94. This ban is quoted by Rabbi Yaacov Reischer (1670-1734) in his *Shevut Ya'akov*, 1,

- *13, and seems to contradict the Talmud in 'Erubin. Rabbi Reischer attempts to answer the contradictions. For further discussion, and other answers to the question, see R. Moses Feinstein, *Iggerot Moshe, Yoreh De'ab*, Vol. 2, #174, section 2.
95. 59:11. Regarding the author of this work, see H.Y.D. Azulai, *Shem ha-Gedolim, Ma'arekhet Sefarim*, 6, #125. See also Menachem Kasher and Yaakov Mandelbaum, *Sarei ha-Eleph* (New York, 1959), 257.
96. See Rama, *Sbulhan 'Arukh, Orach Hayyim* 330:5. Cf. *Sbe'elot u-Teshuvot ba-Rama*, #40.
97. See the excellent article by H.J. Zimmels, "The Significance of the Statement 'We are not Acquainted Anymore' as Echoed in Rabbinic Literature," in *The Leo Jung Jubilee Volume* (New York 1962), 223-35.
98. Y. Shafran, *op. cit.* (n. 83), 50, n. 7 quotes this position in the name of R. Ovadiah Yoseph.

David J. Schnall

By the Light of the Moon: Interfacing Halakhah and Employee Relations

Recent government statistics suggest that over 7.2 million American workers currently hold more than one regular job. Known variously as "moonlighting," supplementary employment or multiple job-holding, it includes members of the work-force who hold primary jobs, generally full-time, while supplementing their incomes with full or part-time employment, after-hours.

Though they constitute only about one in twenty workers, the presence of these multiple job-holders has consistently increased over the past two decades, both in numbers and proportion. For example, in 1975 only 4.7% of all workers held more than one job. However, a special survey conducted by the United States Department of Labor indicated that, by 1989, the rate had risen to 6.2%. Significantly, the percentage of female workers who engaged in moonlighting in 1975 was only 2.9%. By 1989, that figure more than doubled to 5.9%.¹

The data reflect several socioeconomic factors. Almost half of those surveyed indicated that they indulged in moonlighting to meet regular household expenses and pay off current debt. The fact that highest rates were recorded among married men between 35-44 years of age reinforces the phenomenon.

The findings also reflect increases in the percentage of women in

This paper is dedicated to the memory of Rabbi I. Harry Shoulson, for whom the union of Torah u-Madda was a way of life.