

An Unexplained Death

Hannah Greener and Chloroform

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HANNAH Greener of Winlaton, near Newcastle in the United Kingdom, died more than 150 yr ago, on January 28, 1848, after receiving a chloroform anesthetic for the removal of a toenail. She was a healthy 15-yr-old girl who had successfully undergone an anesthetic with diethyl ether several months before for the removal of another toenail. Hers was the first death (fig. 1) attributed to the new and wondrous blessing of anesthesia for surgical pain relief.¹ Various authors have ascribed her death to an anesthetic overdose, aspiration of the water and brandy used in attempts to resuscitate her, or some combination of secondary complications that will never be determined.

During the past century and a half, understanding of the etiology of perioperative deaths has increased remarkably. What can be learned from another analysis of the facts surrounding the death of Hannah Greener? Is pulmonary aspiration as the proximal cause of her death a realistic possibility? Did she receive an overdose of chloroform as many of the contemporary physicians argued, or using our 21st-century knowledge, is there a better explanation of her untimely death?

Just the “Facts”

Thomas Nathaniel Meggison, the physician who administered Hannah Greener’s anesthetic, initially described the events of that day at a coroner’s inquest on February 1, 1848. The verbatim proceedings were pub-

lished in the *Edinburgh Medical and Surgical Journal*. Mr. Meggison, a surgeon, stated that:

I seated her in a chair, and put a teaspoon of chloroform into a tablecloth, and held it to her nose. After she had drawn her breath twice, she pulled my hand down. I told her to draw her breath naturally, which she did, and in about a half a minute I observed muscles of the arm become rigid, and her breathing a little quickened, but not stertorous. I had my hand on her pulse, which was natural, until the muscles became rigid. It then appeared somewhat weaker—not altered in frequency. I then told Mr. Lloyd, my assistant, to begin the operation, which he did, and took the nail off. When the semicircular incision was made, she gave a struggle or jerk, which I thought was from the chloroform not having taken sufficient effect. I did not apply anymore. Her eyes were closed, and I opened them, and they remained open. Her mouth was open, and her lips and face blanched. When I opened her eyes, they were congested. I called for water when I saw her face blanched, and I dashed some of it in her face. It had no effect. I then gave her some brandy, a little of which she swallowed with difficulty. I then laid her on the floor and attempted to bleed her in the arm and jugular vein, but only obtained about a spoonful. She was dead, I believe, at the time I attempted to bleed her. The last time I felt her pulse was immediately perviously to the blanched appearance coming on, and when she gave a jerk. The time would not have been more than 3 min from her first inhaling the chloroform till her death.²

The results of the inquest were reported in the *London Medical Gazette*³ (additional details and images documenting findings reported here are available in the Web Enhancement). A postmortem examination was performed by Sir John Fife and Dr. Robert Mortimer Glover and was reported at the inquest by Sir John. They found that Hannah’s lungs were “in a very high state of congestion” with patches of a deep purple, blueish or scarlet hue,³ but they were not collapsed. A bloody froth was present on sectioning the alveoli. The stomach was distended with food. The heart contained a dark fluid, and there was little blood in the left atrium and ventricle.³

Mr. Meggison also submitted correspondence dated February 3, 1848, which was published with the proceedings of the inquest⁴ (additional details are available in the Web Enhancement). Several details differed from the account in the *Edinburgh Medical and Surgical Journal*.² Meggison reported that in addition to checking Hannah’s pupil, he also pinched her cheek to assure insensitivity before proceeding with the surgery. He also stated that Hannah was “sputtering somewhat” after she blanched. He also admitted to giving his patient some water orally before administering brandy. In his deposition,² Meggison claimed that Hannah Greener swallowed, as he did not in the letter to the *London Medical Gazette*.⁴

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BURIALS in the Parish of <i>Winlaton</i> in the County of <i>Durham</i> in the Year 18 <i>90</i>				
Name.	Abode.	When buried.	Age.	By whom the Ceremony was performed.
<i>Isabella Atkinson</i> No. 1089.	<i>Winlaton</i>	<i>Jan^y 7.</i> <i>12.</i>	<i>85</i> <i>years</i>	<i>Charles</i> <i>Tinley</i>
<i>Wm Goughly</i> No. 1090.	<i>Spou</i>	<i>Jan^y 13.</i>	<i>16</i> <i>years</i>	<i>Charles</i> <i>Tinley</i>
<i>Hannah Greener</i> No. 1091.	<i>Winlaton</i>	<i>Jan^y 30.</i>	<i>15</i> <i>years</i>	<i>Charles</i> <i>Tinley</i>

Fig. 1. Hannah Greener's burial record from parish of Winlaton, county of Durham, United Kingdom. The notation in the right margin reads "Died from the effects of Chloroform." Used with permission.¹⁷

J. M. Flavell, the coroner, read into the inquest's record a report by Dr. Glover published in the *Medical Gazette* involving experiments on animals to which chloroform was administered. Dr. Glover had injected chloroform intravenously into mice and examined their lungs after death. Glover found that the lungs of the mice were congested in a similar way to Miss Greener's. These findings, coupled with the postmortem findings and the depositions of Sir John Fife and Dr. Glover, led the coroner's jury to conclude that "Hannah Greener died of congestion of the lung produced by [the direct effects of] chloroform."³ It was a decision that was soon to be aggressively debated by the leading physicians of the day. As Barbara Duncum points out in her classic book, *The Development of Inhalational Anesthesia*, the case exemplified the dangers of anesthesia to a medical community that was just beginning to understand the physiologic state induced by these new drugs.⁵

Simpson versus Snow

Dr. James Young Simpson, who had discovered the anesthetic effects of chloroform less than a year before Hannah's death and who was a major proponent of chloroform for obstetric anesthesia,⁶ quickly weighed in on the medical issues surrounding this anesthetic death. Writing in the first volume of *The Lancet* (additional details are available in the Web Enhancement), Simpson rejected the idea that chloroform's intrinsic action on the lungs caused the pulmonary edema seen during the autopsy.⁷ Simpson noted that the blanching experienced at the time of the incision was not rare, and he believed that "removal of the handkerchief or inhaler" and "free admission of air to the face" would have allowed the patient to recover. Failing this, he recommended "compressing the chest" and "artificial respiration" if "further measures are required." In Simpson's opinion, it was the

brandy and water Meggison gave to Hannah that was the proximate cause of her death, or in his words, "died from the effects of the means used to restore her from the state of anaesthesia." Simpson believed that the postmortem finding of pink froth in the lungs supported this contention.⁷

However, John Snow, anaesthetist to Queen Victoria and noted epidemiologist,⁸ believed that "the fatal result should be attributed to the action of the chloroform on the nervous centers having extended so far as to put a stop to respiration." Snow emphasized that with chloroform, as contrasted with diethyl ether, a patient could go from being awake to very deep anesthesia quickly⁹ (additional details are available in the Web Enhancement). He believed that inhalers were much safer than the administration of chloroform using the handkerchief method. Shortly after Hannah Greener's death, Snow published a series of articles on the stages of narcotism of anesthetic vapors.¹⁰ He believed it was rapid attainment of the last or "fifth degree of narcotism, in which respiratory movements are more or less paralyzed" that killed Miss Greener.^{8,9} Snow also worked on developing a vaporizer to administer known quantities of chloroform to a patient. There can be little doubt that Hannah Greener's death was used to promote Snow's ideas of increased patient safety by more careful titration of anesthetic depth using inhalers. Snow was trying to change the accepted practice, and this case gave him a perfect opportunity.

Interestingly, in writing his article, Snow interpreted Meggison's story and changed the emphasis of a couple of key points. Snow wrote directly to Meggison about "the nature of the breathing after the [chloroform] inhalation was stopped"⁹ and was able to elicit a scenario previously not presented and published it in the *London Medical Gazette*. Snow clearly interpreted the new information as rapidly changing respiratory patterns as the depth of anesthesia deepened culminating in "a prolonged forced respiration"⁹ as evidence of the "fifth degree of narcotism."⁹ Also, Snow downplayed the effects of the water and brandy.⁹ So great was John Snow's stature that the British medical community revisited the death of Hannah Greener, and an anonymous editorial in the *London Medical Gazette* noted that "[we] agree with Dr. Snow that the vapor was given in too concentrated a form and too rapidly, and that it destroyed life"¹¹ (additional details are available in the Web Enhancement). Interestingly, in 1858, Snow reported the first 50 deaths during chloroform anesthesia.¹² In this report, Snow stated that he believed the majority of deaths were caused by "cardiac paralysis" and not the effects of the anesthetic on inhibiting the respiratory center in the brain. However, it was his first assessment of the death of Hannah Greener that took hold with the medical community. As late as 1908, the American Medical Asso-

ciation concluded "all accidents of chloroform are due to overdosage."¹³

Henry K. Beecher

Approximately 100 yr later, Henry K. Beecher, the Dorr Professor of Anesthesia at Harvard University, entered the historical debate. Fresh from the laboratory, Beecher was touting the merits of anesthetic research in assessing the toxicity of anesthetic agents. Beecher cited Goodman Levy's experiments performed in 1911 with light chloroform anesthesia and epinephrine induction of fatal cardiac arrhythmia. When cats under light chloroform anesthesia were injected with a small dose of intravenous epinephrine, sudden ventricular fibrillation occurred.¹⁴ Beecher concluded that the anesthetic Meggison administered was inadequate for the procedure—the patient was "light." When surgery began, the stimulation from the incision caused a secretion of epinephrine from the adrenals, which caused an already sensitized heart to stop.¹⁵ He used the history of the evolution of the thinking about the causes of the death of Hannah Greener as an example of the importance of performing laboratory research on anesthetic agents.

Inferences

Given the current early 21st-century knowledge, what can be inferred from these descriptions of the events that surrounded Hannah Greener's death? The differential diagnosis boils down to four realistic possibilities. First, Hannah died of a lethal arrhythmia; second, the cause of death was pulmonary aspiration with asphyxia. The third possibility is that Meggison administered a lethal dose of chloroform. Finally, and clearly the most unlikely, was the coroner's jury finding that chloroform directly chemically injured the lungs, leading to Hannah Greener's death.

The fourth diagnosis is perhaps the easiest to eliminate. Although there was evidence given during the coroner's inquest that chloroform can cause this type of lung injury, this seems to occur during exposure of the lung tissue to very high concentrates of anesthetic. Meggison was specific about the amount of chloroform used, 1 teaspoon, and the fact that he placed it on a handkerchief before administering it to the patient. How then, could the chloroform have reached the lungs in sufficient concentration required to cause the pathologic changes seen at autopsy?

The third diagnosis, that Meggison administered a lethal dose of chloroform to Hannah Greener, is also fairly easy to dismiss. Hannah was a healthy 15-yr-old girl. She

had recently received an ether anesthetic for the same procedure on the other foot without apparent difficulty¹⁶ (additional details are available in the Web Enhancement). The description of the events of surgery that day, including the fact that Hannah moved with incision, points in the direction of light anesthesia rather than an overdose. Meggison himself believed that the anesthetic needed to be deepened and was preparing to do so when Hannah stopped breathing.

The first and second possibilities, a lethal arrhythmia *versus* aspiration, remain far more difficult to dismiss. Given the time course of the events, less than 3 min from the induction of anesthesia to the patient's death, there clearly had to be a significant interruption of circulation as evidenced at the time that Meggison tried to bleed the patient. Miss Greener was a young patient, under light chloroform anesthesia, so it is possible that the catecholamine surge experienced with incision caused pulseless ventricular tachycardia or ventricular fibrillation of Hannah's heart.

What was the cause of the obvious pulmonary edema? Water was splashed on Hannah's face, brandy was placed in her mouth, and she may have swallowed. At autopsy, her stomach was full. Could these liquids or stomach contents have been aspirated? It seems likely given the patient's level of consciousness. It would explain the autopsy findings in the lung. In addition, perhaps the water or brandy also induced laryngospasm, and the pulmonary edema is secondary to her attempting to breathe against a closed glottis.

Conclusions

It is impossible, more than 150 yr after the event, to identify definitively what killed Hannah Greener. A review of Meggison's description of the events and the postmortem examination with a contemporary anatomic pathologist[‡] did not permit a definitive conclusion to be made. Despite advances in diagnostic pathology during the past century and a half, without properly preserved tissue specimens, the pathologist could not reach a conclusive diagnosis as to the cause of death. Lethal arrhythmia and pulmonary aspiration were determined to be equally valid hypotheses. It is up to the reader to decide whether the patient was already dead when the brandy was administered, thus differentiating between the two most likely causes of death.

However, in looking back on more than 150 yr of controversy about the death of Hannah Greener, several impressions stand out. First, it is interesting and instructional to observe how one's frame of reference can lead to an observer bias and cause even the most learned and respected physician to interpret facts to fit the individual's prejudices. However, it is also noteworthy that lacking the sophisticated diagnostic equipment and

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knowledge of anesthetic action available today, shortly after the patient's death, the two leading possibilities were brought forth for discussion. Simpson championed pulmonary aspiration as the cause of death. Although Hannah may have already been dead because of a fatal arrhythmia, Simpson was correct to be concerned about the methods used to revive her. These efforts did not do her any good and may have been the proximate cause of her death. Snow initially supported the anesthetic overdose hypothesis of her death. Snow later changed his opinion and believed that Hannah's demise was a primary cardiac event. Beecher reinforced this idea almost 100 yr later, and the diagnosis of a fatal arrhythmia event still seems the most likely explanation for Miss Greener's rapid death. Simpson's and Snow's powers of observation and deductive reasoning are remarkable and can be used as strong examples for every physician practicing anesthesia today.

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