

RESULTS OF A MULTI-PART TRIAL DESIGNED TO REDUCE THE INCIDENCE OF TRAUMATIC HAY-HOLE FALLS

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Hay-hole fall injuries are a unique problem among rural Anabaptist communities, particularly for the pediatric population. In Pennsylvania, many farms have two-story bank barns that have grain and hay on the upper level of the barn, with an animal feeding area – composed of dirt or concrete – 8 to 10 feet below.¹

Hay holes are rectangular openings on the second floor of these barns that are used to drop feed to the ground level and to ventilate the barn (see Fig. 1 on page 8). Without these hay holes, barn temperatures rise and become potential fire hazards. However, these hay holes contribute to falls among the Anabaptist population and can be fatal for children.

Anabaptist youth, including those in Amish, Old Order Mennonite, and Brethren communities, actively participate in work on the farm or are present on the farm when parents and older siblings are working. As they are recruited to assist with agricultural work, particularly on farms, injuries are more prevalent.^{2,6} One study revealed the risk of any injury for those children who work on farms is three times that of children who do not work on farms.⁷

The Centers for Disease Control and Prevention reports that agricultural occupations are among the most hazardous occupations in the United States: 33 children are injured in farm-related accidents every day, and a child dies in a farm-related accident once every three days.² Registry data from Penn Medicine Lancaster General Health and the Penn State Health

Milton S. Hershey Medical Center, including case reports of 53 falls over the course of 15 years, demonstrate that hay-hole falls are rarely fatal but are more likely than urban injuries to be associated with craniofacial trauma.⁸

Hay-hole covers may be employed when hay holes are not in use, but covers themselves pose a problem because they may restrict the airflow during summer months. Thus, a concern about the increased risk of high heat and fire may explain why barn owners do not already employ this injury-prevention mechanism. Thus, the goal of two studies conducted by our team was to determine if an alternative hay-hole cover, designed to be safe and yet allow for ventilation, would be adopted for use by farmers and barn owners.

The Anabaptist Youth Trauma Prevention Consortium (AYTPC) assembled in 2015 to address the issue of hay-hole falls in the Anabaptist communities in South Central Pennsylvania. This task force included family and emergency medicine physicians, nurses, educators, trauma leaders, and representatives from the Pennsylvania Amish Safety Committee (PASC) made up of leaders from the local Lancaster community.¹

The AYTPC presented two hay-hole cover models for feedback at a countywide Farm & Family Safety Day initiative. The favored model consisted of a 1¼-inch-diameter thick-walled steel conduit pipe frame with a meshed, nylon netting interior (see Fig. 2 on page 9).

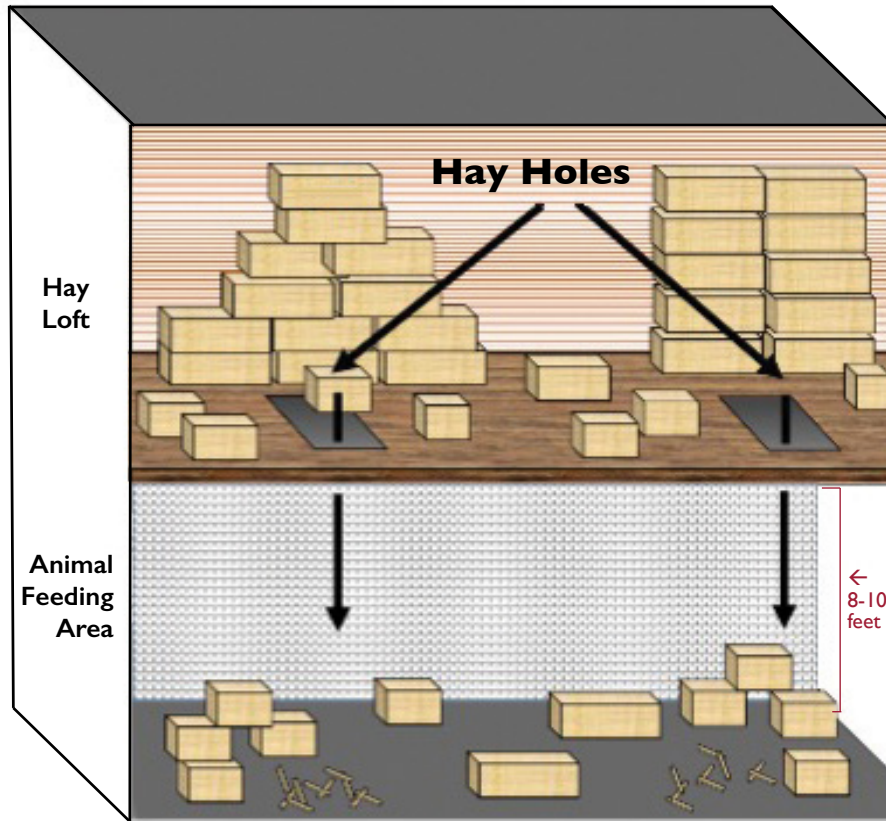


Fig. 1. Hay-hole schematic.

This model has a breaking point of 719 ft-lb and can support at least 620 pounds during net static loading.

The cover is hinged on one side of the hay hole to allow the hay hole to open and close as needed. In addition, the cover is equipped with a removable lining such that in the summer, just the mesh cover is used to allow for air to move through and ventilate the loft (see Fig. 2). In the winter, when there is less concern about entrapped heat, an additional black tarp lining can be added.

This model was selected by the Anabaptist community at a Lancaster Farm & Family Safety Day, receiving overwhelming positive feedback due to its durability and ability to ventilate the hayloft, providing safety without increasing the risk for fire.

METHODS AND RESULTS

Hay-Hole Cover Distribution Pilot Phase

A hay-hole cover distribution pilot phase was conducted during the winter of 2015-2016 and was accompanied by a before-and-after survey, meant to help characterize use of the hay-hole cover and determine whether the covers had resulted in a change in

incidence of injury. A sample of 25 hay-hole covers was distributed to barn owners throughout Lancaster County for a three-month testing period, and subsequent survey followed.

Out of the 25 barn owners included in the first sample group, 23 (92%) completed the presurvey and 19 (76%) completed the postsurvey. In the presurvey, 61% of recipients reported at least one hay-hole fall had occurred on their farm, with 29% (n = 4) resulting in serious injuries.¹ A median of one (1-2) hay-hole fall per residence and a median of three (2-4) hay holes per property were reported.

Cover Distribution Study Phase

The hay-hole cover distribution study phase was conducted later that same year. This was performed in the same manner, with a before-and-after survey designed to characterize whether covers were used and to determine the effect of their use.

An additional 206 hay-hole covers were distributed throughout eight counties in South Central Pennsylvania. The farms receiving covers were in Lancaster, Lebanon, Cumberland, Chester, York, Berks, Dau-

phin, and Adams counties – identified in Lancaster General Hospital trauma registry data and PASC as regions with an incidence of hay-hole injuries.

Although our studies have focused efforts on South Central Pennsylvania, because most Anabaptist communities are settled in this region, Anabaptists can be found in all but three Pennsylvania counties.^{9,10}

When including those who received hay-hole covers in both the pilot and study phases, there were a total of 231 hay-hole covers distributed (n = 231), and 54 barn owners completed presurveys for the study. At least one hay-hole fall was reported by 52% of these recipients leading up to the distribution, and 46% of recipients reported they had had more than one fall at their farm.

Postsurvey revealed a 97% compliance rate with cover installation, and no hay-hole falls were documented after installation of the new cover.

POST HOC ANALYSIS

Several years after completion of this hay-hole cover distribution study, we conducted a post hoc review of data comparing the six-year period before the distribution of hay-hole covers to the five-year period after the distribution of hay-hole covers to determine whether there was a decrease in hay-hole falls in South Central Pennsylvania.²

We conducted a retrospective review of all trauma patients admitted to Lancaster General Hospital from January 1, 2011, to December 31, 2021, with a hay-

hole fall. Data from the hospital’s trauma registry and individual electronic medical records were stratified by phase: Before Implementation of Hay-Hole Covers: 1/2011-12/2016 and After Implementation of Hay-Hole Covers: 1/2017-12/2021.

The results of this post-hoc analysis demonstrate that 49 patients met the inclusion criteria, 41 of whom were members of the Anabaptist community, according to an electronic chart review.

Further analysis shows that 32 patients sustained a hay-hole fall before distribution of the hay-hole covers, and 17 patients sustained a fall after the distribution and use of hay-hole covers. Thus, LGH data demonstrate that 5.3 patients per year presented with a hay-hole fall before the distribution, while 3.4 patients per year presented after the distribution, a 35.9% relative risk reduction in the number of hay-hole falls in the region after distribution of 231 hay-hole covers.

The mean age of patients presenting to LGH with trauma related to a hay-hole fall increased from 11.5 years before cover implementation to 22.4 years after cover implementation (p = 0.035), meaning that fewer children fell through hay holes after covers were implemented in these communities. There were no significant differences in gender, mortality, or injury patterns (head bleed, concussion, spinal fracture, facial fracture, loss of consciousness, skull fracture, or lower and upper extremity fractures) between the two time periods. However, males made up the majority of hay-hole falls both before and after cover implementation.

DISCUSSION

Hay-hole covers with the capacity to ventilate can decrease falls and injuries. Given the decreased incidence of hay-hole falls in South Central Pennsylvania following the distribution of hay-hole covers to barn owners, as well as the increased mean age in which these falls occurred, it is reasonable to conclude that these covers were well received by the Anabaptist community. This study’s authors won the Eastern Association for the Surgery of Trauma’s 2017 Cox Templeton Injury Prevention Competition.

While there is no formal plan for sale or distribution, Lancaster County Farm & Family Safety Day events are an opportunity for barn owners to inquire about hay-hole covers. Periodically, grants allow the AYTFC to provide these covers to interested farmers at no cost.



Fig. 2. Hay-hole cover model favored by the Amish community.

In addition, the hay-hole cover model may be adapted in other rural communities across the country and could prevent hay-hole falls throughout a more widespread area.

The trauma department at Lancaster General Hospital continues to collaborate with different

hospital departments as well as with the Anabaptist community to promote safety and reduce injuries. Our collaboration and research allow us to learn more about injury patterns and characteristics to provide better patient care and prevent injuries in our community.

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