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Life on the farm: A community-based study of tractor-related injuries and fatalities

Agriculture is a particularly dangerous industry when taking into account occupational injury and fatality rates. In 2010, the fatality rate for agriculture was 27.9 per 100,000 workers, which is dramatically higher than the reported incidence of 3.6 deaths per 100,000 workers for all other occupations combined [1]. Tractor mishaps are a significant cause of machinery-related injuries on farms, accounting for an estimated 4–14% of nonfatal injuries and one-third of fatal agricultural injuries [2]. Safety equipment such as rollover protective structures, master shields covering the power take-off (PTO), and driveline and power input connection guards have been introduced in newer tractors in order to help prevent injury [3]. However many tractors currently in use were manufactured prior to these installments and operators may find it too expensive or cumbersome to have their equipment fitted with these devices [3]. Misuse of equipment, having children on or around these machines, and use of tractors on public roads also introduce an increased chance for injury or death [3]. Emergency department (ED) personnel may have little or no familiarity or knowledge about the hazards of agricultural work, including what to expect with tractor-related injuries. The purpose of this study was to characterize the incidence, injury characteristics, and outcomes of tractor-related injuries in West Michigan.

We conducted a retrospective cohort analysis of ED patients with a tractor-related injury seen in seven participating hospitals in West Michigan from January 2002 to August 2016. Data was collected on demographics, mechanisms of injury, diagnoses, treatment provided, and mortality rate. Additional farm fatalities secondary to tractor-related incidents were identified using data from the Michigan Fatality Assessment and Control Evaluation (MIFACE) research program [4]. These fatalities occurred in West Michigan during the study period but were not seen in participating hospitals. Descriptive statistics and frequency tables were used to describe the key quantitative and qualitative variables.

We evaluated 208 patients presenting to participating hospitals with 507 tractor-related injuries during the study period. The mean age was 42.0 ± 20.0 with a range of 3–86 years. Twenty-nine patients (13.9%) were <18 years of age and 11 (5.3%) were >70 years old. A total of 73 patients (35.1%) had injuries classified as severe (trauma priority 1 or 2). Leading types of injury in all age groups were fractures (n = 119, 57.2%) followed by open wounds and contusions/abrasions (Table 1). The majority of fractures involved the upper or lower extremities (79.3%), followed by fractures to the spine (11.5%), pelvis (4.8%) and skull (4.4%).

Overall, the most common mechanisms of nonfatal tractor-related injuries were having an extremity pinned, caught or lacerated (n = 81, 38.9%), followed by tractor run over (n = 34, 16.4%) (Table 2). The frequencies of the injury mechanisms were different in children with the most common mechanism being a fall/jump/ejection (n = 16, 55.2%), followed by a run over (n = 7, 24.1%). A total of 76 patients (36.9%) were admitted to the hospital (LOS 7.9 ± 7.7 days) with four subsequent fatalities (1.9%).

Table 1
Injury characteristics.

	Number of patients (%)
Fracture	119 (57.2%)
Open wound	83 (39.9%)
Contusion/abrasion	77 (37.0%)
Crush injury	40 (19.2%)
Head injury	37 (17.8%)
Sprain/strain	35 (16.8%)
Chest injury	19 (9.1%)
Extremity amputations	17 (8.2%)
Abdominal injury	14 (6.7%)
Dislocation	9 (4.3%)
Burn	8 (3.9%)
Other	9 (4.3%)

According to MIFACE, a total of 119 agriculture fatalities occurred in Western Michigan between 2002 and 2016, and 63 (52.9%) were tractor-related [4]. Causes of death included tractor overturn (46%), run over (16%), and road collisions (11%), among others. Documented reasons for these fatalities include a relative lack of safety training and seat belt use, fatigue and carelessness, lack of emergency preparedness, and exposure of high risk groups like children and elderly to hazardous environments.

Our study supports facts previously found in that various processes may lead to a tractor-related injury, and these mechanisms vary by age and impact on the severity of the resulting injury [1]. Although fractures and soft-tissue extremity wounds are commonly reported, in our study approximately one-third of patients had severe traumatic injuries. ED physicians must be prepared to handle a wide variety of injuries in tractor-related incidents. A particularly disturbing aspect of this study is the frequency of injuries to children, who make up a substantial portion of rural farm staff. It is common for children to work in agriculture at a young age, especially since they are protected by Federal labor laws implemented by the US Department of Labor to a lesser extent than children in other areas of the workforce. For example, laws declare it hazardous for children under 16 years of age to operate a tractor and other heavy machinery on farms, but in other realms, individuals must be 18 or older to operate hazardous equipment [5]. Investigation of unsafe working conditions is often completed by the Office of Safety and Health Administration (OSHA), of which there are both Federal and State offices [6]. Reports to these offices must be taken seriously and investigated thoroughly. Ensuring proper training and oversight for agricultural workers is a must. It would also be prudent to ensure heavy machinery such as tractors either

Table 2
Tractor related injuries in West Michigan 2002–2016.

	Number of patients (%)
Pinned/caught/cut	81 (38.9%)
Tractor - run over	34 (16.4%)
Tractor - fall/jump/ejection	30 (14.4%)
Tractor - overturn	16 (7.7%)
Struck	8 (3.8%)
Tractor PTO entanglement	7 (3.4%)
Road collisions	3 (1.4%)
Other	29 (13.9%)

come equipped or are retrofitted with the most current safety equipment since rollover deaths have been documented since the 1920s [7]. Finally, training and information for ED doctors, first responders, and other care givers about the hazards and possible outcomes of tractor injuries, especially in rural healthcare systems, could lead to faster response times and more comprehensive care [7].

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Refining reflex urine culture testing in the ED

Screening for urinary tract infections is often performed by urinalysis (UA) which measures specific urine elements such as nitrites, white blood cells (WBC), and leukocyte esterase (LE). In our Emergency Department (ED), a positive UA, defined as positive nitrite, or >3 WBC, or positive LE, will automatically generate a urine culture to identify and quantify bacteriuria for specimens ordered as a UA with reflex to culture. Our institution's policy is that antibiotic treatment will be provided for patients with urine culture results yielding 60,000 colony-forming units (cfu) per milliliter (ml). Culture results of ≥60,000 cfu per ml are reviewed by an ED physician to determine the course of action and treatment. Although treatment is based on chart review, there is inclination to treat positive UA and culture results ≥60,000 cfu per ml. The Infectious Disease Society of America states there is no measureable benefit to screen for asymptomatic bacteriuria for most adults >18 years of age, unless atypical symptoms or patient characteristics are present [1-4].

UA with reflex to culture is a common laboratory order that was initially designed to reduce the number of urine cultures and antibiotic treatment for patients with negative UA results [5-7]. However, reflexing specimens to urine culture based on positive UA does not include indications for UTI in the reflex algorithm [8,9]. Urine cultures ordered without clinical indication can lead to inappropriate antimicrobial treatment [10-14]. It is recommended that EDs examine automatic reflexes to culture based on UA results [15].

In an urban tertiary care hospital in Illinois, USA from January 2016–December 2016, 23,722 UA specimens from the ED were ordered as a UA with reflex to culture. Of the 23,722 specimens, 8721 were cultured, 2701/8721 (31%) were positive, defined as bacteriuria ≥60,000 cfu per mL or positive for yeast, and 6020/8721 (69%) were negative, defined as no growth or non-diagnostic growth (<60,000 cfu per ml).

This project was approved by the local institutional review board as non-human subjects research. Through cause mapping, the project team discovered that 1) the high number of negative urine cultures was linked to UA with reflex to culture being ordered without an indication, 2) UA with reflex to culture was pre-checked in several ED order sets, and 3) reflex to culture thresholds were less sensitive compared to other institutions. Additionally, not all physicians were clear on guidelines of when it was appropriate to order a UA with reflex to culture in the ED.

Based on completion of an impact to effort matrix and failure modes and effects analysis, the project team decided to update the ED abdominal pain and psychiatric pre-checked order sets, which had the highest negative urine culture rate, from pre-checked UA with reflex to culture to pre-checked UA, with urine culture available but unchecked. Education on when to screen for and treat a UTI, based on Infectious Disease Society of America guidelines, was provided at Emergency Medicine department meetings to ED attending physicians, administration and leadership, and midlevel providers [1-4]. A hardcopy of the information was given to attendees and an email was sent to all ED providers. The reflex to culture threshold was changed from >3 WBC to >4 WBC. UA specimens positive for nitrite or LE continued to reflex to urine culture. By incorporating the changes into the process of ordering urine cultures, the team believed the results would be sustainable long-term.

Data was analyzed 5 months pre- and post-intervention. All statistics were performed in Minitab Statistical Software Version 18.1. A p-value of <0.05 was considered significant. The number of UA with reflex to culture orders per day was reduced from 92 orders per day to 49 orders per day (mean) post-intervention (t-test, $p < 0.001$) (Fig. 1A). The number of UA orders per day without reflex was significantly increased from 3 orders per day to 41 orders per day (median) post-intervention (Mann-Whitney U Test, $p < 0.001$) (Fig. 1B). The number of negative urine cultures per day was significantly reduced from 13 cultures per day to 6 cultures per day (median), a 54% reduction in negative urine cultures post-intervention with an estimated cost savings of $71,350 per year based on direct costs of urine cultures (Mann-Whitney U Test, $p < 0.001$) (Fig. 2).

ED patient volumes remained stable throughout the pre- and post-intervention time periods. There were no significant changes in the number of 72-hour returns to the ED and 30-day readmissions with diagnosis of UTI, sepsis, bacteremia, or pyelonephritis post-intervention (Fig. 3A–B).

Providing education on when it is appropriate to screen for and treat a UTI, updating pre-checked order sets, and increasing reflex to culture thresholds led to a decreased number of negative urine cultures, reducing the high cost of quality waste from inappropriate urine culture testing in the ED. There is substantial opportunity for decreasing costs and