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Injury Rates on New and Old Technology Oil and Gas Rigs Operated by the Largest United States Onshore Drilling Contractor

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Abstract

Background—Occupational fatality rates among oil and gas extraction industry and specifically among drilling contractor workers are high compared to the U.S. all-industry average. There is scant literature focused on non-fatal injuries among drilling contractors, some of which have introduced engineering controls to improve rig efficiency and reduce injury risk.

Methods—We compared injury rates on new and old technology rigs operated by the largest U.S. drilling contractor during 2003–2012, stratifying by job type and grouping outcomes by injury severity and body part affected.

Results—Six hundred seventy-one injuries were recorded over 77.4 million person-hours. The rate on new rigs was 66% of that on old rigs. Roughnecks had lower injury rates on new rigs, largely through reduced limb injury rates. New rigs had lower rates in each non-fatal injury severity category.

Conclusions—For this company, new technology rigs appear to provide a safer environment for roughnecks. Future studies could include data from additional companies.

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Mention of any company or product does not constitute endorsement by the National Institute for Occupational Safety and Health.

Keywords

oil and gas extraction; drilling contractors; domestic energy; occupational injuries; engineering controls

INTRODUCTION

The U.S. Energy Information Administration (EIA) projects continued growth in domestic oil and natural gas (O&G) production [EIA, 2013]. Depending on economic, regulatory, and geological factors, the U.S. could be a net exporter of natural gas by 2020 and oil by the mid-2030s, while also meeting a large portion of domestic demand [EIA, 2013]. During the period 2003–2012, U.S. O&G extraction industry (operators, drilling contractors, and well servicing companies) employment grew by 92% to 562,300 [BLS, 2013]. Within the drilling contractor portion of the industry [North American Industry Classification System (NAICS) code 213111] there was a 79% increase from 51,500 to 92,300 employees during the same period, paralleling an 85% rise in the number of active rigs [Baker Hughes, 2013; BLS 2013]. The occupational fatality rate among O&G extraction workers, which accounts for industry employment numbers, has risen along with increases in domestic onshore drilling activity during recent years [Mode and Conway, 2008]. This may be due to longer work hours, a higher proportion of novice workers, or use of all functional rigs in a fleet, including those with older equipment. Contact with objects (e.g., workers struck or crushed by equipment) is the second leading cause of occupational fatality among O&G extraction workers, after transportation incidents [Mode and Conway, 2008].

Workers employed by drilling contractors (companies hired to drill wells) have occupational fatality rates that are eleven times the U.S. all-industry average, which is substantially higher than the fatality rate for operators and well servicing companies [Retzer et al., 2011]. Rigs used to drill wells vary from mechanical rigs to alternating current (AC) drive rigs with automated or mechanized equipment. Updating fleets requires investment by contractors, but could improve safety and efficiency. Newer rigs have engineering controls designed to reduce worker exposure to heavy equipment. To our knowledge there is no literature focused on non-fatal injury rates among U.S. drilling contractors, or on differences in injury rates between new and old rigs.

Helmerich & Payne International Drilling Company (H&P) is the largest drilling contractor in the U.S. in terms of footage drilled and well starts, and its workers account for 15% of person-hours among onshore drilling contractors [DataWright, 2013]. H&P collected data on Occupational Safety and Health Administration (OSHA) recordable injuries among employees and third party contractors during 2003–2012, when both new and old rigs (criteria defined below) were used. Data were analyzed by the National Institute for Occupational Safety and Health (NIOSH) to compare injury rates by rig type.

METHODS

The NIOSH Institutional Review Board approved this study [HSRB# 13-DRDS-NR02]. Variables recorded for each injury included year, rig number and type, worker's job type,

OSHA injury severity classification, and body part(s) affected. During 2003–2012, H&P used six categories of land-based rigs. Each was classified by the company as “new” or “old” based on design characteristics. A rig was new if it contained at least one engineering control designed to reduce worker exposure to hazardous equipment. Examples include mechanization of handling equipment used to move drill pipe from ground level to the rig floor, including hydraulic catwalks, and mechanization of tongs for gripping and torqueing drill pipe. In addition, new rigs must have had an AC drive motor, which allows remote joystick control of the traveling block from a climate-controlled cabin as well as fine control of drill pipe rotation using a top-drive system which has the ability to slow or stop drilling while maintaining torque. Rigs were classified as old if they didn’t meet these criteria. On old rigs, drilling was powered mechanically or by silicon controlled rectifiers (SCR) to supply electrical power to direct current (DC) motors. Old rigs also include conventional rigs where drillers use a mechanical brake handle to operate the drawworks (winch) from the rig floor.

SAS software version 9.3 (Cary, NC) was used for analysis. The company recorded total person-hours by year for individual rigs, each of which had a unique identifier. Each injury was associated with a rig number and a year, and each rig was classified as one of the two broad rig types. Injury rates were calculated by rig type, and incidence rate ratios (IRRs) and measures of statistical significance were estimated. Rates were compared across job type categories, and outcomes were grouped according to injury severity and body part affected to assess differences in injury characteristics by rig type. Job type was categorized as: floorman, motorman, derrickman, rig manager/driller/assistant driller/pithand (MDAP), and third party employee. The first three job types listed commonly involve “roughnecking” duties, which are located closer to the wellbore and require frequent interaction with moving equipment. Injury severity included (from less to more severe): medical attention beyond first aid, restricted work, lost time away from work, and fatality. Body part affected was categorized as: head/neck, trunk, arms, wrist/hand, lower limbs, and other. Per industry standard, injury rates were calculated per 200,000 person-hours.

RESULTS

H&P operated 321 rigs during 2003–2012; 57.9 million person-hours were recorded on new rigs and 19.5 million on old rigs. By 2007 there was a marked trend toward increased use of new rigs and decreased use of old rigs (Fig. 1). There were 445 injuries recorded on new rigs and 226 on old rigs. Each of the four fatalities occurred on new rigs. The overall injury rate on new rigs was 66% of that on old rigs (Fig. 2, IRR 0.66, 95% CI 0.57–0.78), and although both rig types had overall injury rate declines, the year-to-year change on old rigs appeared to be less consistent after 2008, coinciding with a marked decline in person-years worked on old rigs.

Stratifying workers by job type and grouping outcomes by OSHA severity and body part affected, rates were generally lower on new rigs, but differences were not always significant. Floormen, motormen, and derrickmen had lower injury rates on new rigs; there was no significant difference in the MDAP or third party categories (Table I). Floormen had the highest injury rate on both old and new rigs, while motormen had the lowest IRR. New rigs

had lower rates of injuries requiring medical attention, restricted work, and lost time away from work. Lost time injuries, the most severe non-fatal category, had the lowest IRR of the severity categories, with the rate on new rigs about half of that observed on old rigs. Rates of arm, wrist/hand, and lower limb injuries were lower on new rigs, but there was no statistically significant difference for other body parts. Three injuries in the “other” category were related to heat/cold exposure. The four fatalities occurred on new rigs, which recorded three times more person-hours than old rigs. Each fatality resulted from an injury to the head/neck or trunk. Two involved third party employees (one struck by injury and one electrocution), one involved a driller (pinch point injury), and one involved a floorman (struck by injury).

DISCUSSION

Roughnecks generally had higher injury rates compared to those performing jobs with presumably less exposure to heavy equipment, but these were also the only job categories for which we observed significantly lower injury rates on new rigs. Floormen are entry-level employees who perform rig maintenance and repair, trip pipes into and out of the wellbore, and assist in rig up and down activities. Motormen operate and maintain rig equipment in addition to performing many floorman duties. Derrickmen handle pipes and maintain the drilling fluid system. Floormen had a significantly lower injury rate on new compared to old rigs, but it was still more than three times higher than the rate for any other job type. Future considerations for improving engineering controls and safety programs should devote special attention to this category of workers. Although those working in MDAP positions or as third party employees did not have significantly lower injury rates on new rigs, 153 total injuries still occurred within these categories, and health and safety initiatives should also include considerations for these employees.

Lost time injuries accounted for less than 10% of injuries, but are disruptive events for workers and employers. Days away from work is an important injury severity metric, and employees of U.S. drilling contractors have a median of thirty days away, higher than the all-industry median of 7 days [BLS, 2010]. Limb injury rates were lower on new rigs; engineering controls on these rigs included updated technology for spinning pipes and completing connections, designed to improve grip, rotation, and torque control. On old rigs, connections were made using manual tongs. Seven percent of incidents (and 8% of lost time incidents) reported by the International Association of Drilling Contractors during 2012 involved manual tongs, which suggests many rig workers still use them [IADC, 2013]. Injuries to the head/neck and trunk may have more severe consequences [Courtney et al., 2001]. New rigs had modestly lower injury rates for these categories, but differences were not statistically significant. Improved understanding of events commonly associated with head/neck and trunk injuries could help drilling contractors develop appropriate interventions.

To our knowledge this is the first study focused on injury rates within the land-based U.S. O&G extraction industry. We analyzed uniformly collected data from the single largest domestic drilling contractor, and these findings may not be representative of all drilling contractors. To better characterize sector-wide trends in rig technology and associated injury

outcomes, future work could include data from additional companies with fleets consisting of both new and old rigs. Without data on job tenure or employee training certifications, we couldn't account for differences in worker experience and training, both of which are crucial components of workplace safety promotion [McNabb et al., 1994]. Because we assessed incidence at the rig level without complementary demographic data on individual workers or relevant environmental factors, it could be that characteristics disproportionately associated with one rig type may explain part of the difference in injury rates. However, because H&P operated old and new rigs concurrently and across a wide area, it's unlikely that ecological factors unduly influenced results. Moving forward, it will be important to design studies to longitudinally assess associations between specific interventions and injury rates.

Within a company accounting for a substantial portion of person-hours worked by U.S. drilling contractors, newer rigs appear to provide a safer work environment, especially for employees with the most exposure to heavy equipment. Rig safety is emphasized in the National Occupational Research Agenda (NORA), which targets a 50% reduction in injuries within the industry by 2020 [NORA, 2011]. The EIA predicts U.S. natural gas production will increase 44% by 2040 [EIA, 2013]. This could have sweeping economic, environmental, and health implications. In light of the previously identified association between drilling activity and occupational fatality rates, and our observation of lower injury rates on new rigs, the potential impact of O&G industry growth and modernization on the health of workers is cause for increased consideration of engineering controls as a method for improving rig safety.

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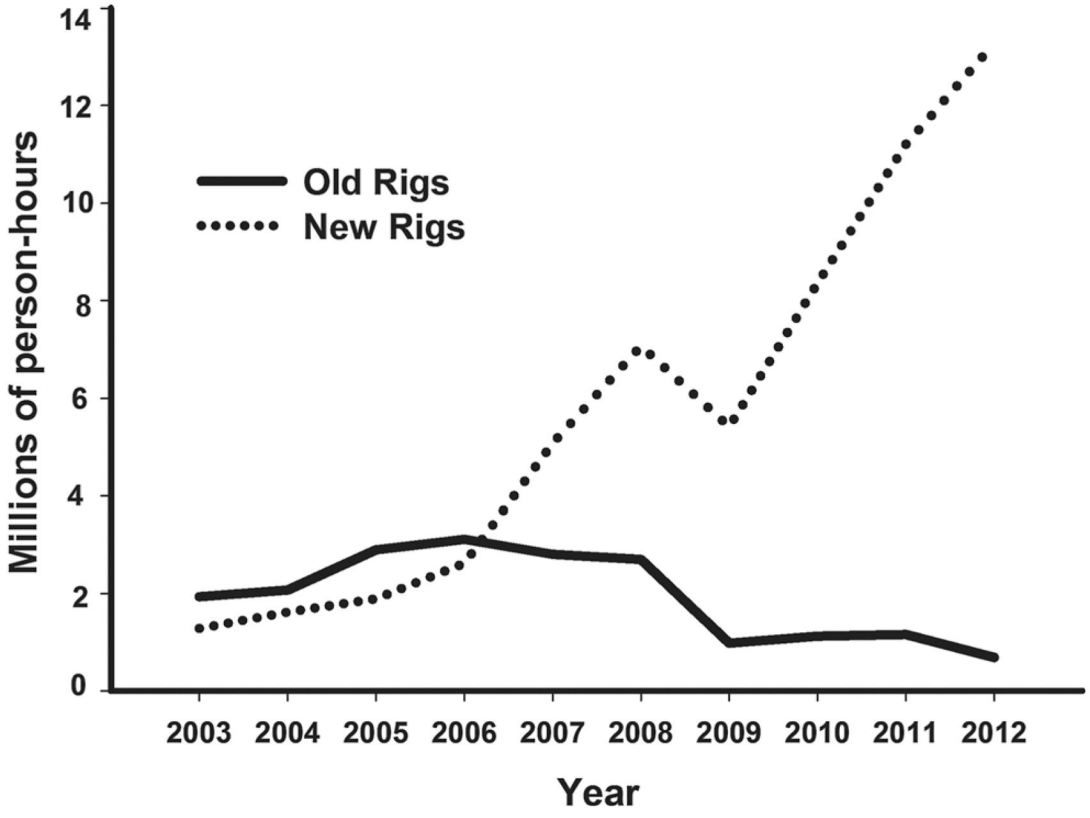

FIGURE 1.
Person-hours worked, by rig type, Helmerich & Payne, 2003–2012.

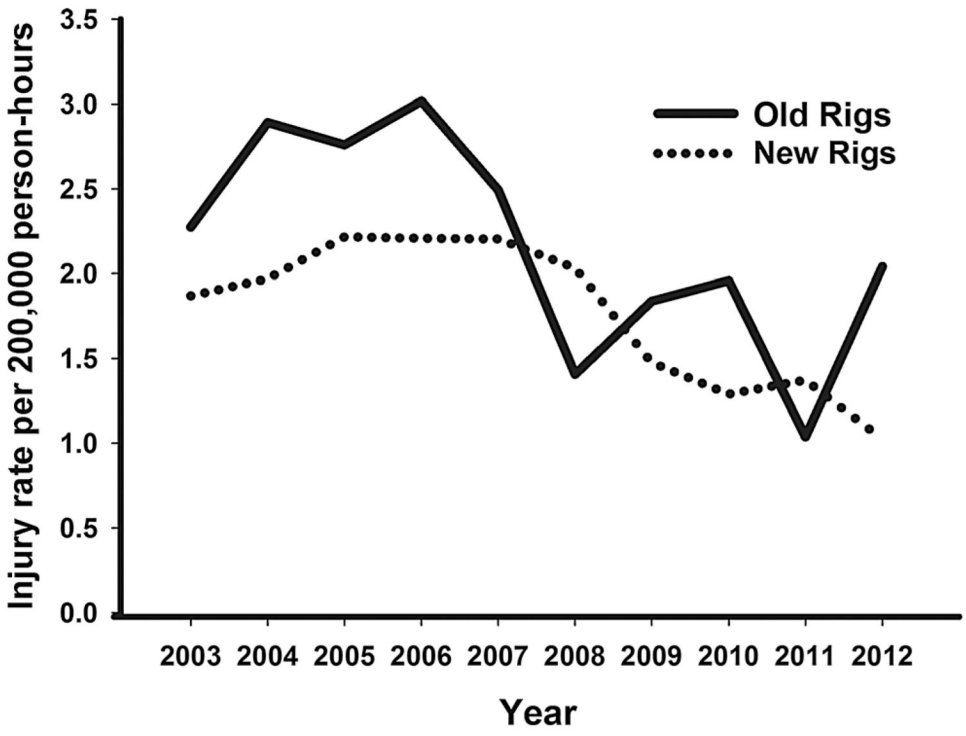

FIGURE 2.
Injury rates per 200,000 person-hours, by rig type, Helmerich & Payne, 2003–2012.

TABLE I

Injury Counts and Rates by JobType, OSHA Severity, and Body Part(s) Affected, Old and New Rigs, Helmerich & Payne, 2003–2012

	Old rigs		New rigs			
	# Injuries	Rate per 200k[a]	# Injuries	Rate per 200k	Rate ratio[b]	*P*-value[c]
Job type						
Floorman	109	1.12	216	0.75	0.67	<0.01
Motorman	37	0.38	61	0.21	0.55	<0.01
Derrickman	34	0.35	61	0.21	0.60	0.02
Mgr/driller/pit[d]	18	0.19	38	0.13	0.68	0.23
Third party	28	0.29	69	0.24	0.83	0.40
OSHA severity						
Medical attention	131	1.35	276	0.95	0.70	<0.01
Restricted work	74	0.76	131	0.45	0.59	<0.01
Lost time	21	0.22	34	0.12	0.55	0.03
Fatality	0	0	4	0.01	n/a	n/a
Body part(s)						
Head/neck	36	0.37	85	0.29	0.78	0.25
Trunk	17	0.18	43	0.15	0.83	0.57
Arms	30	0.31	39	0.14	0.45	<0.01
Wrist/hand	103	1.06	211	0.73	0.69	<0.01
Lower limbs	38	0.39	66	0.23	0.59	0.01
Other	2	0.02	1	<0.01	0.17	0.32
Total[e]	226	2.32	445	1.54	0.66	<0.01

[a] "Rate per 200k" = injury rate per 200,000 person-hours worked.

[b] Rate ratio is incidence rate ratio for new rigs compared to old rigs.

[c] *P*-values for measures of association are two-tailed.

[d] Mgr/Driller/Pit position category includes rig managers, drillers, assistant drillers, and pithands.

[e] Row presents total injury counts and rates, grouped by rig type.