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KANSAS JOURNAL of MEDICINE

2016 Annual Report of the University of Kansas Health System Poison Control Center

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ABSTRACT

Introduction. This is the 2016 Annual Report of the University of Kansas Health System Poison Control Center (PCC). The PCC is one of 55 certified poison control centers in the United States and serves the state of Kansas 24 hours a day, 365 days a year, with certified specialists in poison information and medical toxicologists. The PCC receives calls from the public, law enforcement, health care professionals, and public health agencies. All calls to the PCC are recorded electronically in the Toxicall® data management system and uploaded in near real-time to the National Poison Data System (NPDS), which is the data repository for all poison control centers in the U.S.

Methods. All encounters reported to the PCC from January 1, 2016 to December 31, 2016 were analyzed. Data recorded for each exposure includes caller location, age, weight, gender, substance exposed to, nature of exposure, route of exposure, interventions, medical outcome, disposition and location of care. Encounters were classified further as human exposure, animal exposure, confirmed non-exposure, or information call (no exposure reported).

Results. The PCC logged 21,965 total encounters in 2016, including 20,713 human exposure cases. The PCC received calls from every county in Kansas. The majority of human exposure cases (50.4%, n = 10,174) were female. Approximately 67% (n = 13,903) of human exposures involved a child (defined as 19 years or less). Most encounters occurred at a residence (94.0%, n = 19,476) and most calls (72.3%, n = 14,964) originated from a residence. The majority of human exposures (n = 18,233) were acute cases (exposures occurring over eight hours or less). Ingestion was the most common route of exposure documented (86.3%, n = 17,882). The most common reported substance in pediatric encounters was cosmetics/personal care products (n = 1,362), followed by household cleaning products (n = 1,301). For adult encounters, sedatives/hypnotics/antipsychotics (n = 1,130) and analgesics (n = 1,103) were the most frequently involved substances. Unintentional exposures were the most common reason for exposures (81.3%, n = 16,836). Most encounters (71.1%, n = 14,732) were managed in a non-healthcare facility (i.e., a residence). Among human exposures, 14,679 involved exposures to pharmaceutical agents while 10,176 involved exposure to non-pharmaceuticals. Medical outcomes were 32% (n = 6,582) no effect, 19% (n = 3,911) minor effect, 8% (n = 1,623) moderate effect, and 2% (n = 348) major effects. There were 15 deaths in 2016 reported to the PCC. Number of exposures, calls from healthcare facilities, cases with moderate or major medical outcomes, and deaths all increased in 2016 compared to 2015.

Conclusions. The results of the 2016 University of Kansas Health System Poison Control annual report demonstrates that the center receives calls from the entire state of Kansas totaling over 20,000 human exposures per year. While pediatric exposures remain the most common, there is an increasing number of calls from healthcare facilities and for cases with serious outcomes. The experience of the PCC is similar to national data. This report supports the continued value of the PCC to both public and acute health care in the state of Kansas. ***Kans J Med 2018;11(2):24-33.***

INTRODUCTION

This is the 2016 Annual Report of University of Kansas Health System Poison Control Center (PCC). The PCC is a 24-hour, 365 day/year health care information resource serving the state of Kansas. It was founded in 1982 and is certified with the American Association of Poison Control Centers (AAPCC). Currently, there are 55 certified poison control centers in the United States. The PCC is staffed by 10 certified specialists in poison information who are either critical care trained nurses or doctors of pharmacy. There is 24-hour back up provided by board certified medical toxicologists. The PCC receives calls from the public, law enforcement, health care professionals, and public health agencies. Encounters may involve an exposed animal or human (Exposure Call) or a request for information with no known exposure (Information Call). The PCC follows all cases to make management recommendations, monitor case progress, and document medical outcome. This information is recorded electronically in the Toxicall® data management system and uploaded in near real-time to the National Poison Data System (NPDS). NPDS is the data warehouse for all of the nation's poison control centers.[1] The NPDS utilizes a products database that contains over 427,000 products to classify exposures. The database is maintained and updated continuously by data analysts at the Micromedex Poisindex® System.[1] The average time to upload data for all PCs is 9.52 minutes, creating a real-time national exposure database and surveillance system.[1] The PCC has the ability to share NPDS real time surveillance with state and local health departments and other regulatory agencies. What follows is analysis and summary of all encounters reported to the PCC from January 1, 2016 to December 31, 2016.

METHODS

All PCC encounters recorded electronically in the Toxicall® data management system from January 1, 2016 to December 31, 2016 were analyzed. Cases were first classified as either an exposure or suspected exposure (Human Exposure, Animal Exposure, Non-Exposure Confirmed Cases) or a request for information with no reported exposure (Information Call). Data extracted includes caller location, age, weight, gender, exposure substance, number of follow-up calls, and nature of exposure (i.e., unintentional, recreational, or intentional). Additional data collected included exposure scenario, route of exposure (oral, dermal, parenteral), interventions, medical outcome (no effect, minor, moderate, severe, or death), disposition (admitted to noncritical care unit, admitted to critical care unit, admitted to psychiatry unit, lost to follow-up, or treated and released) and location of care (non-health care facility or health care facility). For this analysis, a pediatric case was defined as any patient 19 years of age or less.

This is consistent with NPDS methodology. For medical outcome, the following definitions were used: minor - minimally bothersome symptoms, moderate - more pronounced symptoms, usually requiring treatment, and major life threatening signs and symptoms.

Data were analyzed using Microsoft Excel (Microsoft Corp, Redmond, WA).

RESULTS

The PCC logged 21,965 total calls in 2016, including 20,713 human exposure cases, 87 non-exposure confirmed cases, 112 animal exposure cases, and 1,053 information calls. For information calls, drug information (n = 308) was most common reason for calling. Table 1 further describes the encounter types. The PCC made 32,137 follow-up calls in 2016. Follow-up calls were done in 60.9% of human exposure cases. One follow-up call was made in 29.5% of human exposure cases and multiple follow-up calls (range 2 - 44) were made in 31.3% of cases. In human exposure calls for which follow-up calls were made, an average of 2.54 follow-up calls per case were performed.

Table 1. Encounter type.

	Number	%
Exposure		
Human Exposure	20,713	94.32
Animal Exposure	112	0.51
Subtotal	**20,825**	**94.83**
Non-Exposure Confirmed Cases		
Human Non-Exposure	87	0.39
Subtotal	**87**	**0.39**
Information Call		
Drug information	308	1.40
Drug identification	189	0.86
Environmental information	123	0.56
Medical information	30	0.14
Occupational information	1	0.00
Poison information	110	0.50
Prevention/Safety/Education	30	0.14
Teratogenicity information	1	0.00
Other information	49	0.22
Substance abuse	6	0.03
Administrative	16	0.07
Caller referred	190	0.86
Subtotal	**1,053**	**4.78**
Total	**21,965**	**100.00**

The PCC received calls from all 105 counties in Kansas. The county with the most number of calls was Sedgwick County with 3,358. In addition, calls were received from 47 states, the District of Columbia, and 12 calls were from foreign countries, including Turkey and Uganda.

The majority of human exposure cases (50.4%, n = 10,174) were female. A male predominance was found among encounters involving children younger than 13 years of age, but this gender distribution was reversed in teenagers and adults, with females comprising the majority of reported exposures. Approximately 67% (n = 13,903) of human exposures involved a child (defined as age 19 years or less). Table 2 illustrates distribution of human exposures by age and gender. Figure 1 demonstrates that patients 1 year of age were the most common age group involved in encounters reported to the PCC. For adults, the age group of 20 - 29 years old was encountered most commonly (Figure 2). Seventy-five (75) exposures occurred in pregnant women (0.4% of all human exposures). Of these exposures, 26.7% occurred in the first trimester, 42.7% occurred in the second trimester, and 28.0% occurred in the third trimester. Most of these exposures (78.7%) were unintentional exposures and 12.0% were intentional exposures. There were no reported deaths to PCC in pregnant women in 2016.

For human exposures, 72.3% (n = 14,964) of calls originated from a residence (own or other), while 94.0% (n = 19,476) of these exposures actually occurred at a residence (own or other). Calls from a health care facility accounted for 21.7% (n = 4,500) of human exposure encounters. Table 3 further details the origin of human exposure calls and where the exposure took place.

The majority of human exposures (n = 18,233) were acute cases (exposures occurring over eight hours or less). Chronic exposures (exposures occurring > 8 hours) accounted for 1.6% (327) of all human exposures reported. Acute on chronic exposures (single exposure that was preceded by a chronic exposure > 8 hours) totaled 2063 (9.96%). Ingestion was the most common route of exposure documented (86.3%, n = 17,882) in all cases (Table 4).

The most common reported substance in those less than 5 years of age was cosmetics/personal care products (n = 1362) followed closely by household cleaning products (n = 1,301). For adult (> 20 years of age) encounters, sedatives/hypnotics/antipsychotics (n = 1,130) and analgesics (n = 1,103) were the most frequently involved substances. Among all encounters, analgesics (n = 2,813, 11%) were the most frequently encountered substance category. Table 5 lists most frequently encountered substance categories for pediatric encounters and Table 6 lists those for adult encounters. [A summary log for all exposures categorized by category and sub-category of substance is available with the manuscript on the website: kjm.kumc.edu].

There were a total of 399 plant exposures reported to the PCC. The most common plant exposure encountered was to pokeweed (Phytolacca Americana; n = 48). Table 7 lists the top 5 most encountered plants.

Table 2. Distribution of human exposures by age and gender.

	Male		Female		Unknown Gender		Total		Cumulative Total	
Age (yrs.)	N	Age Group Total (%)	N	Age Group Total (%)	N	Age Group Total (%)	N	Total Exposure (%)	N	%
< 1	619	52.32	526	47.73	1	0.09	1,183	5.71	1,183	5.71
1	1,971	53.26	1,626	46.50	2	0.06	3,701	17.87	4,884	23.58
2	1,773	52.39	1,579	46.30	1	0.03	3,384	16.34	82,68	39.92
3	852	55.32	681	45.49	3	0.20	1,540	7.43	9,808	47.35
4	400	58.48	320	44.02	2	0.28	684	3.30	10,492	50.65
5	245	56.71	204	47.11	0	0.00	432	2.09	10,924	52.74
Unknown ≤ 5	2	33.33	0	0.00	0	0.00	6	0.03	10,930	52.77
Child 6 - 12	768	61.89	470	39.83	1	0.08	1,241	5.99	12,171	58.76
Teen 13 - 19	620	35.98	990	62.15	2	0.13	1,723	8.32	13,894	67.08
Unknown child	5	55.56	7	46.67	0	0.00	9	0.04	13,903	67.12
Subtotal	**7,255**	**52.18**	**6,403**	**47.58**	**12**	**0.09**	**13,903**	**67.12**	**13,903**	**67.12**
20 - 29	841	47.30	924	52.77	1	0.06	1,778	8.58	15,681	75.71
30 - 39	577	41.72	747	56.12	2	0.15	1,383	6.68	17,064	82.38
40 - 49	447	42.53	558	56.94	3	0.31	1,051	5.07	18,115	87.46
50 - 59	364	40.40	565	57.77	0	0.00	901	4.35	19,016	91.81
60 - 69	292	39.25	411	57.97	1	0.14	744	3.59	19,760	95.40
70 - 79	166	37.22	260	59.50	1	0.23	446	2.15	20,206	97.55
80 - 89	81	33.20	150	64.94	1	0.43	244	1.18	20,450	98.73
≥ 90	12	32.43	40	67.80	0	0.00	37	0.18	20,487	98.91
Unknown adult	47	36.43	107	66.88	1	0.63	129	0.62	20,616	99.53
Subtotal	**2,827**	**42.11**	**3,762**	**56.69**	**10**	**0.15**	**6,713**	**32.41**	**20,616**	**99.53**
Total*	**10,096**	**48.74**	**10,174**	**50.59**	**26**	**0.13**	**20,713**	**100.00**	**20,713**	**100.00**

*Total includes 97 unknown age cases.

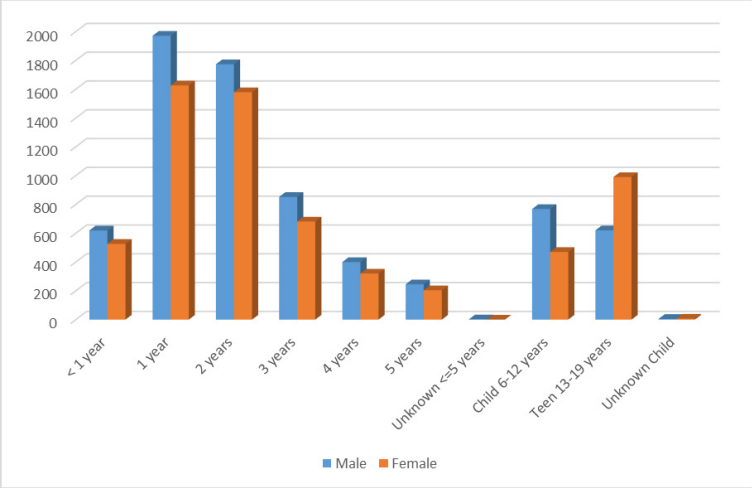

Figure 1. Distribution of human exposures by gender in children < 19 years old.

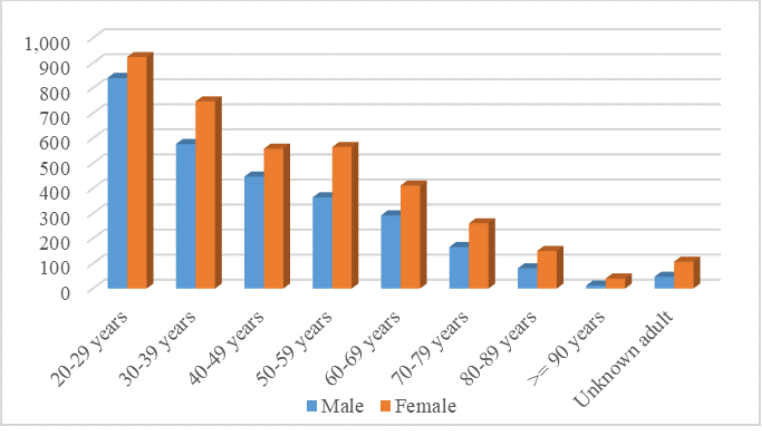

Figure 2. Distribution of human exposures by gender in adults > 20 years old.

Table 3. Origin of call and site exposure for human exposure cases.

Site	Origin of Call		Site of Exposure	
	N	%	N	%
Residence				
Own	14,583	70.41	18,708	90.32
Other	381	1.84	768	3.71
Workplace	324	1.56	395	1.91
Health care facility	4,500	21.73	71	0.34
School	54	0.26	242	1.17
Restaurant/Food service	8	0.04	30	0.14
Public area	63	0.30	181	0.87
Other	775	3.74	164	0.79
Unknown	25	0.12	154	0.74

Table 4. Route of human exposures.

	Human Exposures		
Route	**N**	**% of All Routes**	**% of All Cases**
Ingestion	17,882	82.44	86.33
Dermal	1,312	6.05	6.33
Inhalation/nasal	1,095	5.05	5.29
Ocular	855	3.94	4.13
Bite/sting	215	0.99	1.04
Unknown	157	0.72	0.76
Parenteral	115	0.53	0.56
Other	25	0.12	0.12
Otic	17	0.08	0.08
Rectal	8	0.04	0.04
Aspiration (with ingestion)	5	0.02	0.02
Vaginal	5	0.02	0.02
Total Number of Routes	**21,691**	**100.00**	**104.72***

*Some cases may have multiple routes of exposure documented.

Table 5. Substance categories frequently involved in exposures for ≤ 5 years old.

Substance Category	All Substances	%	Single Substance Exposures	%
Cosmetics/Personal care products	1,362	11.89	1,333	12.62
Cleaning substances (household)	1,301	11.36	1,259	11.92
Analgesics	1,073	9.37	966	9.14
Foreign bodies/Toys/ Misc.	610	5.32	589	5.57
Antihistamines	590	5.15	537	5.08
Topical preparations	577	5.04	572	5.41
Vitamins	510	4.45	466	4.41
Dietary supplements/ Herbals/Homeopathic	430	3.75	401	3.80
Pesticides	418	3.65	408	3.86
Plants	282	2.46	260	2.46
Gastrointestinal preparations	276	2.41	246	2.33
Cold and cough preparations	250	2.18	228	2.16
Antimicrobials	241	2.10	213	2.02
Hormones and hormone antagonists	227	1.98	157	1.49
Cardiovascular drugs	213	1.86	131	1.24

Table 6. Substance categories frequently involved in exposures of adults (> 20 years old).

Substance Category	All Substances	%	Single Substance Exposures	%
Sedative/Hypnotics/ Antipsychotics	1,130	11.65	319	6.14
Analgesics	1,103	11.37	508	9.77
Antidepressants	786	8.10	248	4.77
Cardiovascular drugs	654	6.74	223	4.29
Pesticides	434	4.47	378	7.27
Cleaning substances (household)	405	4.18	314	6.04
Alcohols	403	4.15	55	1.06
Anticonvulsants	378	3.90	111	2.14
Antihistamines	333	3.43	151	2.91
Hormones and hormone antagonists	272	2.80	135	2.60
Stimulants and street drugs	267	2.75	116	2.23
Chemicals	233	2.40	205	3.94
Cosmetics/Personal care products	210	2.16	188	3.62
Cold and cough preparations	197	2.03	101	1.94
Muscle relaxants	190	1.96	67	1.29

Table 7. Top 5 most frequent plant exposures.

Botanical Name or Category	N
Phytolacca americana (L.) (Pokeweed)	48
Plants: Unknown Toxic Types or Unknown if Toxic	46
Spathiphyllum species (Peace Lily)	14
Philodendron (Species unspecified)	16
Cherry (Species unspecified)	12

Unintentional exposures were the most common reason for exposures (81.3%, n = 16,836) while intentional exposures accounted for 16.3% (n = 3,377) of exposures. Table 8 lists reasons for human exposures. A majority of unintentional exposures (n = 10,897) occurred in the less than 5-years-old age group. Up to age 12, 98.9% (n = 12,171) of ingestions were unintentional. However, in the 13 - 19 year-old group, intentional exposure was most common (63.1%, n = 1,087). In total, suspected suicide attempts accounted for 11.7% (n = 2,415) of human encounters. When a therapeutic error was the reason for exposure, a double dose was the most common scenario (n = 775).

Most encounters (71.1%, n = 14,732) were managed in a non-health care facility (i.e., a residence). Of the 5,747 encounters managed at a health care facility, 42% (n = 2,419) were admitted. Table 9 lists the management site of all human encounters.

Table 8. Reason for human exposure cases.

Reason	N	% Human Exposures
Unintentional		
General	11,971	57.8
Therapeutic error	2,361	11.4
Misuse	1,226	5.9
Environmental	625	3.0
Occupational	238	1.1
Bite/sting	217	1.0
Food poisoning	160	0.8
Unknown	38	0.2
Subtotal	**16,836**	**81.3**
Intentional		
Suspected suicide	2,415	11.7
Misuse	527	2.5
Abuse	348	1.7
Unknown	87	0.4
Subtotal	**3,377**	**16.3**
Adverse Reaction		
Drug	286	1.4
Other	44	0.2
Food	29	0.1
Subtotal	**359**	**1.7**
Unknown Reason	77	0.4
Subtotal	77	0.4
Other		
Malicious	43	0.2
Contamination/Tampering	15	0.1
Withdrawal	6	0.0
Subtotal	**64**	**0.3**
Total	**20,713**	**100.0**

Table 9. Management site of human exposures.

Site of Management	N	%
Managed in healthcare facility		
Treated/evaluated and released	3,153	15.2
Admitted to critical care unit	1,281	6.2
Admitted to noncritical care unit	721	3.5
Admitted to psychiatric facility	417	2.0
Patient lost to follow-up/left AMA	175	0.8
Subtotal (managed in HCF)	**5,747**	**27.8**
Managed on site, non-health care facility	14,732	71.1
Other	19	0.1
Refused referral	197	1.0
Unknown	18	0.1
Total	**20,713**	**100.0**

Among human exposures, 14,679 involved pharmaceutical agents, while 10,176 involved exposure to non-pharmaceuticals. Because an encounter could include both a pharmaceutical agent and non-pharmaceutical agent, this total is greater than the total number of encounters. However, 88.5% (n = 18,327) of all human exposures were exposed to only a single substance. Among these single substance exposures, the reason for exposure was intentional in 19.3% (n = 3,527) of pharmaceutical-only cases compared to 3.5% (n = 641) of non-pharmaceutical single substance exposures.

When medical outcomes were analyzed, 32% (n = 6,582) of human exposures had no effect, 19% (n = 3,911) had minor effect, 8% (n = 1,623) had moderate effect, and 2% (n = 348) had major effects. Moderate and major effects were more common in those over 20 years of age and in those with intentional encounters. More serious outcomes were related to single-substance pharmaceutical exposures, accounting for 66.7% (n = 10) of the fatalities. Table 10 lists all medical outcomes by age and Table 11 lists them by reason for exposure.

Use of decontamination and specific therapies, including antidotal therapy, is detailed in Tables 12a and 12b.

There were 15 deaths in 2016 reported to the PCC. Fourteen of the deaths involved patients 20 years of age or older. Fourteen of the death cases involved intentional exposures. Table 13 details the 15 reported deaths.

Table 14 compares key statistics from 2015 to 2016. Number of exposures, calls from healthcare facilities, moderate or major outcomes, and deaths increased from 2015.

Table 10. Medical outcomes of human exposure cases by patient age.

	≤ 5 yrs		6 - 12 yrs		13 - 19 yrs		≥ 20 yrs		Unknown child		Unknown adult		Unknown age		Total	
Outcome	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
No effect	4,515	41.31	386	31.10	426	24.72	1,244	18.89	0	0.00	9	6.98	2	2.1	6,582	31.78
Minor effect	1,268	11.60	245	19.74	560	32.50	1,805	27.41	1	11.11	27	20.93	5	5.2	3,911	18.88
Moderate effect	92	0.84	39	3.14	309	17.93	1,112	16.89	0	0.00	2	1.55	69	71.1	1,623	7.84
Major effect	10	0.09	4	0.32	66	3.83	268	4.07	0	0.00	0	0.00	0	0.0	348	1.68
Death	0	0.00	0	0.00	1	0.06	12	0.18	0	0.00	0	0.00	0	0.0	13	0.06
No follow-up, nontoxic	435	3.98	31	2.50	10	0.58	39	0.59	0	0.00	2	1.55	1	1.0	518	2.50
No follow-up, minimal toxicity	4,305	39.39	504	40.61	242	14.05	1,542	23.42	4	44.44	53	41.09	8	8.3	6,658	32.14
No follow-up, potentially toxic	207	1.89	16	1.29	73	4.24	281	4.27	3	33.33	24	18.60	10	10.3	614	2.96
Unrelated effect	98	0.90	16	1.29	36	2.09	279	4.24	1	11.11	12	9.30	2	2.1	444	2.14
Death, indirect report	0	0.00	0	0.00	0	0.00	2	0.03	0	0.00	0	0.00	0	0.0	2	0.01
Total	**10,930**	**100.00**	**1,241**	**100.00**	**1,723**	**100.00**	**6,584**	**100.00**	**9**	**100.00**	**129**	**100.00**	**97**	**100.00**	**20,713**	**100.00**

Table 11. Medical outcome by reason for exposure in human exposures.

	Unintentional		Intentional		Other		Adverse reaction		Unknown		Total	
Outcome	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Death	0	0.00	13	0.38	0	0.00	0	0.00	0	0.00	13	0.06
Death, indirect report	0	0.00	1	0.03	0	0.00	0	0.00	1	1.30	2	0.01
Major effect	53	0.31	273	8.08	0	0.00	9	2.51	13	16.88	348	1.68
Minor effect	2,746	16.31	1,012	29.97	19	29.69	121	33.70	13	16.88	3,911	18.88
Moderate effect	574	3.41	978	28.96	5	7.81	46	12.81	20	25.97	1,623	7.84
No effect	5,836	34.66	720	21.32	7	10.94	14	3.90	5	6.49	6,582	31.78
No follow-up, nontoxic	512	3.04	4	0.12	1	1.56	1	0.28	0	0.00	518	2.50
No follow-up, minimal toxicity	6,399	38.01	146	4.32	17	26.56	92	25.63	4	5.19	6,658	32.14
No follow-up, potentially toxic	391	2.32	189	5.60	7	10.94	16	4.46	11	14.29	614	2.96
Unrelated effect	325	1.93	41	1.21	8	12.50	60	16.71	10	12.99	444	2.14
Total	**16,836**	**100.00**	**3,377**	**100.00**	**64**	**100.00**	**359**	**100.00**	**77**	**100.00**	**20,713**	**100.00**

Table 12a. Decontamination provided in human exposures by age.

Decontamination	≤ 5 yrs	6 - 12 yrs	13 - 19 yrs	≥ 20 yrs	Unknown child	Unknown adult	Unknown age	Total
Cathartic	2	3	40	46	0	0	0	91
Charcoal, multiple doses	1	2	9	5	0	0	0	17
Charcoal, single dose	87	14	176	202	0	0	0	479
Dilute/irrigate/wash	8,317	796	445	2,649	7	58	3	12,275
Food/snack	1,516	142	83	369	0	3	1	2,114
Fresh air	67	35	37	403	3	26	3	574
Lavage	0	0	1	6	0	0	0	7
Other emetic	57	6	4	39	0	1	0	107
Whole bowel irrigation	0	0	1	8	0	0	0	9

Table 12b. Therapy provided in human exposures by age.

Therapy	≤ 5 yrs	6 - 12 yrs	13 - 19 yrs	≥ 20 yrs	Unknown child	Unknown adult	Unknown age	Total
Alkalinization	4	2	39	143	0	0	0	188
Antiarrhythmic	0	1	0	5	0	0	0	6
Antibiotics	27	10	19	185	0	2	0	243
Anticonvulsants	0	0	2	5	0	0	0	7
Antiemetics	16	9	128	177	0	0	0	330
Antihistamines	19	8	21	86	0	0	1	135
Antihypertensives	0	0	1	18	0	0	0	19
Antivenin (fab fragment)	1	1	2	8	0	0	0	12
Antivenin/antitoxin	0	1	4	10	0	0	0	15
Atropine	0	1	1	12	0	0	0	14
Benzodiazepines	17	7	93	270	0	0	0	387
Bronchodilators	2	5	2	48	0	2	69	128
Calcium	164	8	3	31	0	0	0	206
CPR	0	0	2	7	0	0	0	9
Deferoxamine	0	0	0	2	0	0	0	2
Ethanol	0	0	0	1	0	0	0	1
Extracorp. procedure (other)	0	0	0	1	0	0	0	1
Fab fragments	0	0	0	8	0	0	0	8
Fluids, IV	57	23	490	1,313	0	1	1	1,885
Flumazenil	0	1	6	33	0	0	0	40
Fomepizole	4	0	2	15	0	0	0	21
Glucagon	1	0	4	25	0	0	0	30
Glucose, > 5%	4	0	1	42	0	0	0	47
Hemodialysis	0	0	3	21	0	0	0	24
Hydroxocobalamin	3	1	0	1	0	0	0	5
Hyperbaric oxygen	0	0	0	2	0	0	0	2
Insulin	0	0	1	23	0	0	0	24
Intubation	3	3	27	153	0	0	0	186
Methylene blue	0	0	0	3	0	0	0	3
NAC, IV	1	0	63	105	0	0	0	169
NAC, PO	1	1	14	19	0	0	0	35
Naloxone	5	1	23	131	0	0	0	160

Table 12b. *Continued.*

Therapy	≤ 5 yrs	6 - 12 yrs	13 - 19 yrs	≥ 20 yrs	Unknown child	Unknown adult	Unknown age	Total
Neuromuscular blocker	2	0	0	6	0	0	0	8
Octreotide	1	0	0	0	0	0	0	1
Other	55	16	99	357	2	3	0	532
Oxygen	9	8	56	379	0	0	69	521
Physostigmine	0	0	4	9	0	0	0	13
Phytonadione	0	0	1	12	0	0	0	13
Sedation (other)	6	5	26	136	0	0	0	173
Sodium thiosulfate	1	0	0	0	0	0	0	1
Steroids	8	2	7	77	0	1	69	164
Vasopressors	0	1	8	65	0	0	0	74
Ventilator	3	3	27	155	0	0	0	188

Table 13. Details on deaths and exposure related fatalities.

Age & Gender	Substances	Substance Rank	Cause Rank	Chronicity	Route	Reason
NON-PHARMACEUTICAL EXPOSURES						
Fumes/Gases/Vapors						
17 year Male	Carbon Monoxide	1	1	Acute	Inhal	Int-S
Heavy Metals						
68 year Female	Copper	1	1	Acute	Ingst	Int-S
PHARMACEUTICAL EXPOSURES						
Analgesics						
73 year Male	Acetaminophen/ Hydrocodone	1	1	Acute on Chronic	Ingst	Int-S
	Zolpidem	2	2	Acute on Chronic	Ingst	
Antihistamines						
38 year Female	Diphenhydramine	1	1	Acute	Ingst	Int-S
Cardiovascular Drugs						
21 year Female	Labetalol	1	1	Unknown	Ingst	Int-S
	Clonazepam	2	2	Unknown	Ingst	
45 year Female	Propranolol	1	1	Acute	Ingst	Int-S
	Valproic Acid	2	2	Acute	Ingst	
	Olanzapine	3	3	Acute	Ingst	
	Bupropion	4	4	Acute	Ingst	
46 year Male	Amlodipine	1	1	Acute on Chronic	Ingst	Int-S
	Lamotrigine	2	2	Acute on Chronic	Ingst	
	Metformin	3	3	Acute on Chronic	Ingst	
	Citalopram	4	4	Acute on Chronic	Ingst	
	Fenobibrate	5	5	Acute on Chronic	Ingst	
	Alpha Blocker	6	6	Acute on Chronic	Ingst	
	Quetiapine	7	7	Acute on Chronic	Ingst	
	Lisinopril	8	8	Acute on Chronic	Ingst	
	Bupropion (Extended Release)	9	9	Acute on Chronic	Ingst	
	Ethanol	10	10	Acute on Chronic	Ingst	

Table 13. *Continued.*

Age & Gender	Substances	Substance Rank	Cause Rank	Chronicity	Route	Reason
46 year Female	Propranolol	1	1	Acute	Ingst	Int-S
	Trazodone	2	2	Acute	Ingst	
	Paroxetine	3	3	Acute	Ingst	
60 year Male	Carvedilol	1	1	Acute on Chronic	Ingst	Int-S
	Amlodipine	2	2	Acute on Chronic	Ingst	
	Hydrochlorothiazide/Lisinopril	3	3	Acute on Chronic	Ingst	
	Clopidogrel	4	4	Acute on Chronic	Ingst	
	Duloxetine	5	5	Acute on Chronic	Ingst	
	Acetaminophen/Hydrocodone	6	6	Acute on Chronic	Ingst	
	Dexlansoprazole	7	7	Acute on Chronic	Ingst	
	Quetiapine	8	8	Acute on Chronic	Ingst	
73 year Female	Metoprolol	1	1	Acute on Chronic	Ingst	Int-S
	Duloxetine	2	2	Acute on Chronic	Ingst	
	Trazodone	3	3	Acute on Chronic	Ingst	
	Donepezil	4	4	Acute on Chronic	Ingst	
	Baclofen	5	5	Acute on Chronic	Ingst	
	Benztropine	6	6	Acute on Chronic	Ingst	
	Lurasidone	7	7	Acute on Chronic	Ingst	
	Alprazolam	8	8	Acute on Chronic	Ingst	
	Zolpidem	9	9	Acute on Chronic	Ingst	
	Meloxicam	10	10	Acute on Chronic	Ingst	
	Salicylate	11	11	Acute on Chronic	Ingst	
	Levothyroxine	12	12	Acute on Chronic	Ingst	
	Omeprazole	13	13	Acute on Chronic	Ingst	
	Vitamin D	14	14	Acute on Chronic	Ingst	
96 year Female	Calcium Antagonist	1	1	Acute	Ingst	Unk
Cold and Cough Preparations						
30 year Male	Dextromethorphan/Guaifenesin	1	1	Acute	Ingst	Int-U
Electrolytes And Minerals						
63 year Female	Iron	1	1	Acute on Chronic	Ingst	Int-S
	Ibuprofen	2	2	Acute on Chronic	Ingst	
	Levothyroxine	3	3	Acute on Chronic	Ingst	
Sedative/Hypnotics/Antipsychotics						
48 year Female	Quetiapine	1	1	Acute on Chronic	Ingst	Int-S
Stimulants and Street Drugs						
20 year Male	Heroin	1	1	Acute on Chronic	Par	Int-A
	Ethanol	2	2	Acute on Chronic	Ingst	

Abbreviations: Inhal: Inhalation; Ingst: Ingestion; Par: Parenteral; Int-S: Intentional-Self; Int-U; Intentional-Unknown; Int-A: Intentional-Another; Unk: Unknown.

Table 14 compares key statistics from 2015 to 2016. Number of exposures, calls from healthcare facilities, moderate or major outcomes and deaths increased from 2015.

Table 14. 2015 to 2016 comparison of select statistics.

	2015	2016
Total Cases	20,109	21,965
Calls from Health Care Facility	4,267	4,514
Moderate or Major Outcomes	1,688	1,971
Deaths	13	15

DISCUSSION

The University of Kansas Health System Poison Control Center has been in operation for 35 years and serves the state of Kansas 24 hours a day, 365 days a year. Receiving over 26,000 calls per year, the PCC is an integral part of the emergency medical response, public health and health care facilities in Kansas. Childhood poisonings, both unintentional and intentional, are a major focus, with calls for patients under 19 years of age accounting for approximately 2/3 of all exposures.

The PCC statistics are similar to those seen nationally.[1] In 2016, 2,710,042 encounters were logged by poison control centers nationwide, including 2,159,032 human exposures. Total encounters showed a 2.9% decline from 2015, but healthcare facility (HCF) human exposure cases increased by 3.6% from 2015. More serious outcomes (moderate, major, or death) also increased. Nationwide, the five substance classes most frequently involved in adult exposures were analgesics, sedative/hypnotics/antipsychotics, antidepressants, cardiovascular drugs, and cleaning substances, while the top five most common exposures in children age 5 years or less were cosmetics/personal care products, household cleaning substances, analgesics, foreign bodies/toys/miscellaneous, and topical preparations. There were 1,415 exposure related fatalities reported nationwide in 2016.

The ongoing importance of the PCC is reflected in current trends that have seen rates of poisonings and overdoses increase at an alarming rate. The PCC saw an increase in number of calls from healthcare facilities, cases with moderate or major medical outcomes and deaths in 2016 compared to 2015. In an August 2017 report, the National Center for Health Statistics noted that the age-adjusted drug-poisoning death rate increased from 6.1 per 100,000 in 1999 to 16.3 per 100,000 in 2015, totaling over 50,000 deaths in 2015.[3] Teenage (age 15 - 19) overdose deaths are increasing as well.[4] The ongoing "opioid epidemic" is a major driver in the rise of poisoning deaths.[3]

Reporting exposures to the PCC is voluntary and the PCC is not contacted for all poisonings in the state of Kansas. Furthermore, in a majority of cases there is no objective confirmation of exposure. These limitations should be noted when interpreting PCC data.

CONCLUSION

The results of the 2016 University of Kansas Health System Poison Control annual report demonstrated that the center receives calls from the entire state of Kansas, totaling over 20,000 human exposures per year. While pediatric exposures remain the most common, there is an increasing number of calls from healthcare facilities and for cases with serious outcomes. The experience of the PCC is similar to national data. This report supports the continued value of the PCC to both public and acute health care in the state of Kansas.

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KANSAS JOURNAL of MEDICINE

Increasing Onshore Oil Production: An Unexpected Explosion in Trauma Patients

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ABSTRACT

Introduction. Few data currently exist which are focused on type and severity of onshore oil extraction-related injuries. The purpose of this study was to evaluate injury patterns among onshore oil field operations.

Methods. A retrospective review was conducted of all trauma patients aged 18 and older with an onshore oil field-related injury admitted to an American College of Surgeons-verified level 1 trauma center between January 1, 2003 and June 30, 2012. Data collected included demographics, injury severity and details, hospital outcomes, and disposition.

Results. A total of 66 patients met inclusion criteria. All patients were male, of which the majority were Caucasian (81.8%, n = 54) with an average age of 36.5 ± 11.8 years, injury severity score of 9.4 ± 8.9, and Glasgow Coma Scale score of 13.8 ± 3.4. Extremity injuries were the most common (43.9%, n = 29), and most were the result of being struck by an object (40.9%, n = 27). Approximately one-third of patients (34.8%, n = 23) were admitted to the intensive care unit. Nine patients (13.6%) required mechanical ventilation while 27 (40.9%) underwent operative treatment. The average hospital length of stay was 5.8 ± 16.6 days, and most patients (78.8%, n = 52) were discharged home. Four patients suffered permanent disabilities, and there were two deaths.

Conclusions. Increased domestic onshore oil production inevitably will result in higher numbers of oil field-related traumas. By focusing on employees who are at the greatest risk for injuries and by targeting the main causes of injuries, training programs can lead to a decrease in injury incidence. ***Kans J Med 2018;11(2):34-37.***

INTRODUCTION

In the United States (U.S.) between 2003 - 2013, the oil and gas extraction industry experienced a 71% increase in the number of active oil rigs.[1] Onshore based operations involving horizontal drilling and fracturing experienced the greatest growth, seeing an increase in employment rates between 40% to 92%.[1-4] One place in particular that saw an increase in the number of onshore rigs due to the success rate of horizontal drilling and hydraulic fracturing operations was Kansas.[5] Although this increase was not as high as rates seen in Texas and Oklahoma, Kansas saw the addition of 1,000 active wells during this time.

In 2011, 1,400 workers directly involved in operating and developing oil and gas field properties and 8,500 workers involved in support activities were injured on the job.[6] Most of these injuries, regardless of whether they were employed at an on- or off-shore facility, were related to highway motor vehicle crashes or extreme impact/crush.[6] However, explosions and flash fires on onshore rigs have become common due to the increased use of fracturing.[4] The median days-away-from-work for those injured while working at or near an oil rig has been reported as three times longer (24 days) compared to all other industries (8 days).[6]

The occupational fatality rate for this industry is four to seven times higher than among U.S. workers in general.[1-3,7,8] The majority of oil and gas extraction-related fatalities are due to transportation incidents and contact with objects or equipment.[1,3,7,8] Factors that may increase the rate of injuries and the frequency of fatalities include working on aging rigs or, for smaller companies, length of time on the job, being subcontracted, or participating in rig maintenance, repairs, or drilling operations.[2,3,8] Human error, equipment failure, and weak operating systems also were contributing factors.[9,10]

The majority of literature on the oil and gas extraction industry addresses the rate of offshore occupational related-injuries.[9-17,19] A closer examination of injury patterns and outcomes among onshore drilling workers could prove beneficial for triage and treatment of the patient in the field and hospital settings, as well as illustrate the need for safety procedures to prevent injury in this industry. The purpose of this study was to evaluate injury patterns in onshore oil field operations.

METHODS

A retrospective review of all adult patients admitted with injuries sustained during the operation or maintenance of onshore oil field machinery between January 1, 2003 and June 30, 2012 was conducted at a single American College of Surgeons-verified level 1 trauma center. Data were retrieved from the trauma registry, as well as from each patient's medical records. Patient data included age, sex, race, injury severity score (ISS), abbreviated injury severity score (AIS), Glasgow Coma Scale (GCS) score, and injury details. Hospitalization data included intensive care unit (ICU) admission and length of stay, mechanical ventilation requirements, and need for operative management. Outcomes data included hospital length of stay, discharge disposition (home, rehabilitation, skilled nursing facility), and mortality.

Descriptive analyses were presented as frequencies with percentages for categorical variables and means with standard deviations for continuous variables. All statistical analyses were conducted using SPSS release 19.0 (IBM Corp., Armonk, New York). This study was approved for implementation by the Institutional Review Board of Via Christi Hospitals Wichita, Inc. and the University of Kansas School of Medicine-Wichita's Human Subjects Committee.

RESULTS

A total of 66 patients met the inclusion criteria for the study. All patients were male, and the majority were Caucasian (81.8%, n = 54) with an average age of 36.5 ± 11.8 years, ISS of 9.4 ± 8.9, and GCS of 13.8 ± 3.4 (Table 1). Based on AIS, the most severely injured body regions were the abdomen (2.7 ± 0.8) and the extremities (2.7 ± 0.7). All injuries were the result of blunt force trauma, and most were the result of being struck by an object (40.9%, n = 27). Falls (19.7%, n = 13) accounted for the second most common cause of injury, followed by caught in machine (12.1%, n = 8), and explosions (10.6%, n = 7).

Table 1. Patient demographics, injury severity, and injury details.

Variable	Percent (N)
Number of Patients	100.0% (66)
Age, years*	36.5 ± 11.8 (66)
Male	100% (66)
Race (Caucasian)	81.8% (54)
Injury Severity Score (ISS)*	9.4 ± 8.9 (66)
Initial Glasgow Coma Scale (GCS) Score*	13.8 ± 3.4 (66)
Abbreviated Injury Severity Score (AIS)*	
Head/neck	2.4 ± 1.1 (21)
Face	1.7 ± 0.6 (15)
Chest	2.6 ± 1.4 (11)
Abdomen	2.7 ± 0.8 (10)
Extremities	2.7 ± 0.7 (31)
External	1.1 ± 0.3 (40)
Type of Accident	
Struck	40.9% (27)
Fall	19.7% (13)
Caught in machine	12.1% (8)
Explosion	10.6% (7)
Pinned	9.1% (6)
Struck with subsequent fall	6.1% (4)
Cut	1.5% (1)

*Mean ± SD

Most injuries were to the lower extremities (25.8%, n = 17; Table 2). Injuries to the head and face also were common, with most involving a facial fracture (22.7%, n = 15) or loss of consciousness (16.7%, n = 11). Among patients who sustained a vertebral spinal fracture, lumbar fractures (12.1%, n = 8) were the most common. Injuries to the thoracic and abdominal regions were not as common.

Slightly over one-third (34.8%, n = 23) of patients were admitted to the ICU with an average length of stay of 1.7 ± 2.5 days (Table 3). Mechanical ventilation was required for 13.6% (n = 9) of patients and 40.9% (n = 27) required surgery. The majority of surgical interventions involved debridement and open reduction of extremity fractures. In addition, four patients required completion of an amputation and one patient required multiple orthopedic and abdominal surgeries. The average hospital length of stay was 5.8 ± 16.6 days, and most patients (78.8%, n = 52) were discharged home. Four patients suffered a permanent disability, and two patients (3.0%) died due to explosion-related injuries.

Table 2. Injury characteristics.*

Injury Parameter	Percent (N)
Head Injury	
Loss of consciousness	16.7% (11)
Concussion	10.6% (7)
Skull fracture	6.1% (4)
Subarachnoid hemorrhage	4.5% (3)
Subdural hematoma	4.5% (3)
Facial Fracture	22.7% (15)
Spine Injury	
Lumbar	12.1% (8)
Thoracic	10.6% (7)
Cervical	1.5% (1)
Spinal cord injury	3.0% (2)
Thoracic Injuries	
Rib fracture	7.6% (5)
Pneumothorax	4.5% (3)
Hemothorax	1.5% (1)
Abdominal Injuries	
Urinary bladder	3.0% (2)
Spleen	1.5% (1)
Renal	1.5% (1)
Pelvic Fracture	7.6% (5)
Hip Fracture	1.5% (1)
Lower Extremity Fractures or Dislocations	25.8% (17)
Upper Extremity Fractures or Dislocations	18.2% (12)
Clavicle/Scapula	3.0% (2)
Burns	9.1% (6)

*A single patient could be subject to multiple injuries.

Table 3. Characterization of hospitalization details and disposition.

Hospital Parameter	Percent (N)
Number of Observations	100.0% (66)
Intensive Care Unit (ICU) Admission	34.8% (23)
ICU length of stay, days*	1.7 ± 2.5 (66)
Mechanical Ventilation	13.6% (9)
Mechanical ventilation days*	0.6 ± 2.3 (66)
Surgery	40.9% (27)
Permeant Disability	6.1% (4)
Hospital Length of Stay, days*	5.8 ± 16.6 (66)
Disposition	
Home	78.8% (52)
Rehabilitation	16.7% (11)
Nursing Facility	1.5% (1)
Death	3.0% (2)

*Mean ± SD

DISCUSSION

With a marked increase in the number of active onshore oil rigs in the United States, there is a correlated increase in injury and fatality rates among oil and gas extraction workers.[1,8] Although there is previous research for offshore oil rigs, there is no study that specifically focuses on onshore oil rig injury characteristics based on hospital data.[1-3] In the current study, extremity fractures and head/facial injuries were the most common. In addition, the majority of injuries were due to the patient being struck by an object or as the result of a fall. The number of fatalities in the current study was low, and both were explosion related.

Our results supported several offshore drilling injury studies.[12,13,16] For example, a study conducted among Venezuelan drillers indicated that most injuries were to the upper (48%) and lower (24%) extremities with the majority resulting from the worker being struck by an object (37%).[12] Our study demonstrated lower rates of upper and lower extremity injuries, 25.8% and 18.2%, respectively; however, the type and cause of these injuries were similar, as was the fact that they were the most common. Another study of Iranian gas refinery workers demonstrated most injuries were caused by being struck by an object (48%).[13] We reported a 40.9% rate of injury associated with being struck. In addition, Mehrdad[13] and Thibodaux[16] reported most injuries caused by an offshore drilling accident were to the extremities.

Fatality statistics from the Bureau of Labor Statistic (BLS) Census of Fatal Occupational Injuries (CFOI) were used for comparisons regarding patient fatality rates.[1,3,6,8] Of note, it has been well documented that CFOI injuries are under-reported in this database.[17,18] The BLS studies demonstrated that most fatal injuries were caused by transportation-related accidents (40%), followed by contact with objects and equipment (26%), fires and explosions (14%), and finally falls, slips, and trips (8%).[1,3,6,8] In the current study, there were no transportation-related fatalities; the two reported deaths were explosion-related.

Possible fall prevention measures for our study population might include the use of a full body harness, impact protective clothing, or the use of personal fall arrest system (PFAS).[4,19,20] To protect workers from dangerous machinery and prevent accidental contact with objects, the use of suitable covers or casings, and barrier rails or screens are needed.[20-21] However, it has been documented that many onshore oil rigs routinely are unassembled and moved quickly resulting in design modifications that may involve removing handrails.[21] Prevention of injuries from being struck by an object may include strongly enforcing Occupational Standard Health Administration (OSHA) personal protective equipment regulations and implementing penalties for workers caught not following these regulations.

Recommendations for future research include amalgamating hospital data with occupational reports to produce an accurate picture of which types of workers sustain the most severe injuries or are at the highest risk for death. For instance, Blakeley et al.[2] reported that improved engineering controls and safety programs would benefit floor men at a higher rate than other job types due to the fact they experience three times the rate of injuries compared to other positions. In addition, due to the small sample size of the current study, expanding beyond a single institution by including multiple hospitals would be beneficial for establishing injury patterns for onshore oil rigs.

This study had several limitations. First, the findings are limited by all known biases associated with retrospective studies. These include a lack of granularity that would allow for the determination of demographic and environmental factors contributing to the injury, such as job type, tenure, training and experience, or lost time away from work. Second, there is a possibility that many patients injured in a rural location were missed due to being admitted to another hospital in the area. Also, it was possible that these rural patients sustained less severe injuries and were treated locally. Likewise, those workers killed at the site and not transported to the hospital were not represented in the analysis. Finally, the small sample size of the study population from a single institution limits the generalizability of the results.

CONCLUSION

There is a growing need for enhanced surveillance of the onshore oil and gas extraction industry to understand risk factors for fatal and non-fatal injuries.[1] To our knowledge, this is one of the first studies focusing solely on onshore oil rig injuries. Study results showed that extremity and head/facial injuries were the most common. In addition, most injuries were the result of patients being struck by an object or as the result of a fall. By targeting the main causes of injuries, training and prevention programs can be created to decrease the incidence of on-the-job injuries among this rapidly growing employment sector.

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Head CT Guidelines Following Concussion Among the Youngest Trauma Patients: Can We Limit Radiation Exposure Following Traumatic Brain Injury?

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ABSTRACT

Introduction. Recent studies have provided guidelines on the use of head computed tomography (CT) scans in pediatric trauma patients. The purpose of this study was to identify the prevalence of these guidelines among concussed pediatric patients.

Methods. A retrospective review was conducted of patients four years or younger with a concussion from blunt trauma. Demographics, head injury characteristics, clinical indicators for head CT scan (severe mechanism, physical exam findings of basilar skull fracture, non-frontal scalp hematoma, Glasgow Coma Scale score, loss of consciousness, neurologic deficit, altered mental status, vomiting, headache, amnesia, irritability, behavioral changes, seizures, lethargy), CT results, and hospital course were collected.

Results. One-hundred thirty-three patients (78.2%) received a head CT scan, 7 (5.3%) of which demonstrated fractures and/or bleeds. All patients with skull fractures and/or bleeds had at least one clinical indicator present on arrival. Clinical indicators that were observed more commonly in patients with positive CT findings than in those with negative CT findings included severe mechanism (100% vs. 54.8%, respectively, p = 0.020) and signs of a basilar skull fracture (28.6% vs. 0.8%, respectively, p = 0.007). Severe mechanism alone was found to be sensitive, but not specific, whereas signs of a basilar skull fracture, headache, behavioral changes, and vomiting were specific, but not sensitive. No neurosurgical procedures were necessary, and there were no deaths.

Conclusions. Clinical indicators were present in patients with positive and negative CT findings. However, severe mechanism of injury and signs of basilar skull fracture were more common for patients with positive CT findings. ***Kans J Med 2018;11(2):38-43.***

INTRODUCTION

Annually, nearly 1.5 million children in the United States aged 14 years and younger sustain a traumatic brain injury.[1] A mild traumatic brain injury (MTBI) is defined as a complex pathophysiologic process induced by traumatic biomechanical forces secondary to direct or indirect forces.[2] Rates of MTBI are highest for children aged four years and under.[1] This age group is a difficult population to examine due to limited verbal skills placing them at particular risk for a missed diagnosis.[1] Most traumatic brain injuries sustained by children four years and younger are minor and not associated with intracranial brain injury.[3-7] However, MTBIs are one of the leading causes of death within this population and must be identified promptly to achieve optimal outcomes.[3-7]

Cranial computed tomography (CT) scanning is highly sensitive for identifying brain injuries.[8] CT scanning is used with increasing regularity in the pediatric population to exclude intracranial brain injuries, with up to 69% of pediatric patients receiving a cranial CT scan.[9,10] However, most cranial CT scans in blunt trauma patients are normal, less than 8% reveal intracranial brain injury, and even fewer require acute intervention.[11,12] Moreover, overuse of CT scanning in children is concerning due to the risk of radiation exposure.[13-15]

In 2001, the American College of Radiology noted that because children have longer life expectancies and their cells divide more rapidly, they have higher radiation sensitivity which can lead to a greater risk of later malignancy than occurs in adults.[16] In addition, growing evidence indicates that children undergo cranial CT scans when it may not always be necessary.[9-15] In response, the Joint Commission issued a Sentinel Event Alert, reminding practitioners to adhere to the ALARA (as low as reasonably achievable) guidelines mandated by the Nuclear Regulatory Commission.[14]

Currently, there is a lack of consensus regarding which pediatric MTBI patients require a CT scan, especially among younger children who present with a minor head injury or concussion (Glasgow Coma Scale [GCS] score of 13 - 15). An example of this lack of consensus is apparent when examining the utilization of pediatric head CT scans within general emergency departments (22%) when compared to pediatric emergency departments (13%).[9] In addition, multiple studies of pediatric head trauma patients vary considerably on which clinical indicators are best at predicting which children are at low-risk for a traumatic brain injury, thus do not require a head CT.[11,17-26]

Clinical indicators that have appeared in these studies include mechanism severity, physical examination findings of a basilar skull fracture, non-frontal scalp hematoma, low GCS score, loss of consciousness (LOC), neurologic deficits, altered mental status, prolonged vomiting, severe headache, amnesia, irritability, behavioral changes, seizures, and lethargy.[11,17-26] The purpose of this study was to determine if the clinical indicators identified in previous studies were present among pediatric patients with a concussion and who had received a head CT scan.

PATIENTS AND METHODS

A retrospective review was conducted of patients younger than or equal to four years presenting to a single Midwestern American College of Surgeons-verified Level 1 Trauma Center between January 1, 2004 and December 31, 2010 following concussion due to blunt head trauma. Patients who died within the first 24 hours of admission, arrived intubated (since head CT would be indicated in this population regardless), and did not have a traumatic brain injury (isolated or non-isolated concussion) were excluded.

Demographic data collected included age and gender. Other collected data included: Injury Severity Score (ISS), head and neck Abbreviated Injury Score (AIS), GCS score, individual injury details, cranial CT scan results, and neurological surgeries performed in the hospital. Clinical indicators assessed in this study included: mechanism of injury (severe or not severe as defined below), physical examination findings of basilar skull fracture (raccoon eyes, Battle's sign, hemotympanum, cerebrospinal fluid from ear/nose), non-frontal scalp hematoma, GCS score less than 15, loss of consciousness, presence of neurological deficit, altered mental status, prolonged vomiting, severe headache, amnesia, irritability, behavioral changes, seizures, and lethargy. Assessed outcomes included: intensive care unit (ICU) admission, ICU length of stay, mechanical ventilator days, need for re-intubation, hospital length of stay, in-hospital mortality, discharge destination, and need for re-admittance to hospital.

Severe mechanism of injury was defined as a motor vehicle collision (MVC) at 40 mph or greater or when the speed was unknown, and when there was an ejection, rollover, or death. Patients struck by a high-impact object or by a motorized vehicle, either while on foot or a bicycle, also were included. Type of falls included were those of more than three feet for patients younger than two years, and more than five feet for patients older than two years. Falls of unknown height, from more than five stairs or unknown amount of stairs, and falls from a bicycle without a helmet also were included. Finally, patients suspected of being the victim of child abuse were included.

Statistical Analysis

Descriptive analyses were presented as frequencies with percentages for categorical variables and means with standard deviations for continuous variables. Primary comparisons were made between patients with negative CT findings versus those with positive CT findings. Continuous variables were compared using one-way analysis of variance for normally distributed data. When heterogeneity of variance was identified, the Mann-Whitney U Test was utilized for analyses. Categorical data were compared using Chi-square analysis or the Fisher's exact test when sample size was small. All tests were two-tailed, and a $p < 0.05$ was considered statistically significant. All statistical analyses were conducted using SPSS software, version 19.0 (IBM Corp., Somers, New York). This study was approved for implementation by the Institutional Review Board of Via Christi Hospitals Wichita, Inc. and the Human Subjects Committee at the University of Kansas School of Medicine-Wichita.

RESULTS

Initially, 189 patients were identified from the trauma registry. A total of 19 patients were excluded from data analyses. Nine were excluded from the study due to being older than four years or having a mechanism other than blunt head trauma. Another nine were excluded because they arrived intubated. One child was excluded due to having a chronic head bleed from an arteriovenous malformation found on imaging studies.

Of the remaining 170 children, most were male (62.9%, n = 107) with a mean age of 28.1 ± 15.9 months (range 0 to 59 months). Most patients presented to the hospital with a median GCS of 15, ISS of 4, and head/neck AIS of 2. The majority of patients had a CT scan (78.2%, n = 133) of which 5.3% (n = 7) were positive for either a cranial fracture and/or bleeding. One patient had an initial head CT that was read as negative, with observation of hemotympanum; however, a follow-up CT demonstrated a resolving subdural hematoma. Clinical findings, CT results, and hospital course for patients with positive CT scans are presented in Table 1.

Table 1. Clinical findings, CT results, and hospital course of patients with positive CT findings.

Patient	Clinical Findings	CT Results	Hospital Course
1	• Ecchymosis right ear • Severe mechanism • Signs of basilar skull fracture • Headache	Nondepressed left occipital calvarial fracture	Pediatric ICU length of stay: 1 day
2	• Forehead bruise • Severe mechanism • Loss of consciousness	Nondisplaced, nondepressed linear skull fracture extending through the right occipital bone into the petrous ridge	Pediatric ICU length of stay: 1 day Neurosurgery consult
3	• Forehead contusion • Left forearm ecchymosis • Severe mechanism • Behavioral changes	Subarachnoid hemorrhage and parietal contusions	Pediatric ICU length of stay: 1 day Neurosurgery consult Repeat CT: stable
4	• Contusion scalp • Severe mechanism • Vomiting	Right parietal fracture extends into the temporal and petrous ridge and right mastoid	Pediatric ICU length of stay: 1 day Neurosurgery consult Repeat CT: stable
5	• Left frontal ecchymosis • Severe mechanism • Loss of consciousness • Vomiting • GCS 14	Tiny subdural hematoma	Pediatric ICU length of stay: 9 days Neurosurgery consult Skeletal series Bone scan MRI Repeat CT: stable
6	• Severe mechanism • Loss of consciousness	High parietal calvarial fracture extends from vertex down about 1.5 cm without intracerebral hemorrhage	Floor length of stay: 1 day Neurosurgery consult Repeat CT: stable
7	• Open wound eardrum • Severe mechanism • Signs of basilar skull fracture	Hemotympanum	Pediatric ICU length of stay: 2 days ENT and neurosurgery consult Skeletal survey Repeat CT: small right subdural hematoma

A comparison of demographics, injury severity, and mechanism of injury between the two groups is shown in Table 2. Demographics, GCS, and ISS were similar between the study groups. Head/neck AIS was greater in the positive CT group (2.7 ± 0.9 vs. 1.9 ± 0.5, respectively, p = 0.002). Most patients (63.2%) were injured as a result of a fall. However, there was no difference between the study groups in regards to mechanism of injury.

Table 2. Comparison of patient demographics, injury severity, and mechanism of injury.

	Total CT	Positive CT	Negative CT	p value
Number of Observations	133 (100%)	7 (5.3%)	126 (94.7%)	---
Age (months)*	29.2 ± 16.2	23.1 ± 22.3	29.5 ± 15.9	0.316
Gender				0.710
Male	83 (62.4%)	5 (71.4%)	78 (61.9%)	
Female	50 (37.6%)	2 (28.6%)	48 (38.1%)	
Injury Severity				
Glasgow Coma Scale (GCS) Score*	14.6 ± 3.5	14.9 ± 0.4	14.6 ± 3.6	0.835
Injury Severity Score*	5.1 ± 3.9	8.4 ± 5.9	4.9 ± 3.7	0.328
Abbreviated Injury Severity Score Head/Neck*	1.9 ± 0.5	2.7 ± 0.9	1.9 ± 0.5	0.0002
Mechanism of Injury				0.192
Falls	84 (63.2%)	5 (71%)	79 (62.7%)	
Struck Accidentally by Object	15 (11.3%)	1 (14.3%)	14 (11.1%)	
Motor Vehicle Crash	27 (20.3%)	0	27 (20.3%)	
Suspected Child Abuse	5 (4.8%)	0	5 (4.0%)	
Pedal Cycle Accident	2 (1.5%)	1 (14.3%)	1 (0.8%)	

*Mean ± standard deviation

Hospital outcomes for the study groups are compared in Table 3. Almost all of the patients with positive CT findings were admitted to a pediatric ICU (85.7%, n = 6), a higher proportion than among patients with negative CT findings (38.1%, n = 48, p = 0.018). There was no difference between the groups for intensive care unit length of stay and hospital length of stay. No neurosurgical procedures and no deaths occurred among the study population. All seven of the children with positive CTs and 97.6% (n = 123) of those with a negative CT were discharged home after treatment.

Table 3. Comparison of patient outcomes.

	Total CT	Positive CT	Negative CT	p value
Number of Observations	133 (100%)	7 (5.3%)	126 (94.7%)	
Hospital Course				
Intensive Care Unit (ICU) Admission	54 (40.6%)	6 (85.7%)	48 (38.1%)	0.018
ICU Length of Stay, d*	1.3 ± 0.9	2.3 ± 3.3	1.2 ± 0.5	0.772
Hospital Length of Stay, d*	1.3 ± 0.9	2.3 ± 3.0	1.3 ± 0.8	0.305
Ventilator Days*	---	---	1.0 ± 0.0	---
In-hospital Deaths After 24 Hours	0	0	0	---
Re-admissions	0	0	0	---
Procedures Performed				
Intubations	0	0	2 (1.6%)	1.000
Re-intubations	0	0	0	---
Neurosurgery	0	0	0	---
Discharged Destination				1.000
Home	130 (97.7%)	7 (100%)	123 (97.6%)	
Other (foster care, against medical advice)	3 (2.3%)	0	3 (2.4%)	

*Mean ± standard deviation

A comparison of the prevalence of clinical indicators between the study groups is shown in Table 4. Most patients had at least one clinical indicator present (95.4%, n = 127). Of the clinical indicators studied, severe mechanism was the most common among the total patient population that received a CT scan (57.1%, n = 76), followed by loss of consciousness (38.3%, n = 51), GCS less than 15 (31.6%, n = 42), and lethargy (26.3%, n = 35). Among the positive CT group, each patient had at least one clinical indicator present on arrival, with six patients having two or more clinical indicators present.

Clinical indicators that were observed more commonly in patients with positive CT findings than in those with negative CT findings included severe mechanism (100% vs. 54.8%, respectively, p = 0.020) and signs of a basilar skull fracture (28.6% vs. 0.8%, respectively, p = 0.007). No other clinical indicators were significantly different between the two groups. Severe mechanism alone was found to be sensitive, but not specific, whereas signs of a basilar skull fracture, headache, behavioral changes, and vomiting were specific, but not sensitive (Table 5).

A subcategory of children with a minor TBI (GCS = 13 - 15) represented 94.7% of the total population (n = 161). The remaining 5.3% (n = 9) had a GCS less than 13 and were considered to have either moderate or severe TBI. Among those with a minor TBI, 77% (124/161) had a head CT performed. Seven of these head CT scans were positive for fractures and/or bleeds.

Table 4. Comparison of patient clinical indicators.

	Total CT (n = 133)	Positive CT (n = 7)	Negative CT (n = 126)	p value
Number of Observations*	127 (95.4%)	7 (100%)	120 (95.2%)	---
Severe Mechanism	76 (57.1%)	7 (100%)	69 (54.8%)	0.020
Loss of Consciousness	51 (38.3%)	3 (42.9%)	48 (40.3%)	1.000
GCS less than 15	42 (31.6%)	1 (14.3%)	41(32.5%)	0.312
Lethargy	35 (26.3%)	0	35 (27.8%)	0.189
Vomiting	26 (19.5%)	2 (28.6%)	24 (19.0%)	0.622
Behavioral Changes	10 (7.5%)	1 (14.3%)	9 (7.1%)	0.429
Seizures	10 (7.5%)	0	10 (7.9%)	1.000
Altered Mental Status	9 (6.8%)	0	9 (7.1%)	1.000
Irritability	8 (6.0%)	0	8 (6.3%)	1.000
Headache	8 (6.0%)	1 (14.3%)	7 (5.6%)	0.359
Signs of Basilar Skull Fracture	3 (2.3%)	2 (28.6%)	1 (0.8%)	0.007
Non-frontal Hematoma	3 (2.3%)	0	3 (2.4%)	1.000
Neurological Deficit	0	0	0	---
Amnesia	0	0	0	---

*A patient may have more than one indicator present.

Table 5. Sensitivity and specificity of clinical indicators based upon initial positive CT findings.

	Number	Sensitivity	Specificity	Positive value*	Negative value*
Clinical Indicators	7	1.00	0.05	0.06	1.00
Severe Mechanism	7	1.00	0.45	0.09	1.00
Loss of Consciousness	3	0.43	0.62	0.06	0.95
Vomiting	2	0.29	0.81	0.08	0.95
Signs of Basilar Skull Fracture	2	0.29	0.99	0.67	0.96
GCS < 15	1	0.14	0.67	0.02	0.93
Headache	1	0.14	0.94	0.13	0.95
Behavioral Changes	1	0.14	0.93	0.10	0.95

*Predicative

DISCUSSION

Literature supports the use of clinical indicators for screening children to determine when to perform a head CT scan.[11,17-26] However, the clinical indicators that are most effective in determining the need for head CT scans in children remain controversial.[11,17-26] In this retrospective study, more patients with a positive CT scan presented with a severe mechanism of injury and signs of basilar skull fracture than patients who had a negative CT scan. In addition, among the seven patients with positive head CT findings, at least one clinical indicator was present on arrival, with six of the seven patients having two clinical indicators present on arrival. Having more than one clinical indicator increases the risk of TBIs substantially.[17,18]

In the current study, signs of basilar skull fracture had the highest predictive value when compared to the other clinical indicators. This is in agreement with previous studies which have demonstrated an association between skull fractures in children and an increased risk of intracranial injuries.[11,17-26] Alhelail et al.[19] demonstrated that signs of basilar skull fractures were associated positively with the presence of subarachnoid hemorrhage, herniation, and cerebral edema. In the present study, among the two patients with a positive CT scan and signs of a basilar skull fracture, one patient had a fracture on their initial scan. The second patient had an original finding of hemotympanum with a subsequent finding of a subdural hematoma.

In addition, the current study results demonstrated that all patients with positive head CT scans suffered a severe mechanism of injury, making it the most common clinical indicator present. Consistent with previous studies, this study also found severe mechanism of injury as a common indicator of TBIs.[18,20,21] However, most of these studies indicated that a combination of clinical indicators is needed to predict a TBI. For example, Nigrovic et al.[17] concluded that children with an isolated severe mechanism of injury had a lower rate of clinically important TBIs than those with a severe mechanism of injury plus an additional clinical indicator. In our study, severe mechanism of injury was not specific for sustaining an intracranial injury as the majority of children with severe mechanisms had normal head CT findings.

Two clinical indicators that were not encountered among this study population included amnesia and neurological deficit. The absence of findings pertaining to amnesia may be due to the fact that the patients or patients' families had not been asked specifically about the condition. More likely, amnesia may be a difficult finding to establish in the younger pediatric population. Alternatively, the absence of patients with neurological deficits may be due to the study's focus on blunt head trauma, as well as the exclusion of patients who arrived intubated.

Most of the pediatric patients in the current study had a head CT (78.2%), with 5.3% of these scans being positive. The CT rate in other studies ranges from a low of 20%, up to 98%.[11,17-26] However, the majority of our population also had at least one clinical indicator present regardless of CT results. A better judgment of our CT rate,

based on using clinical indicators as a guide, is to look at the six patients who did not have a clinical indicator present. Reasons for why these patients may have received a CT despite not having any clinical indicators may include patient age, other clinical findings, physician discretion, or a request from the consulting physician and/or a parent.[27] Due to the retrospective nature of this study, however, this information was not collected.

Among the twelve documented clinical indicators in our study, severe mechanism of injury and signs of basilar skull fracture were the only significantly different clinical indicators between the two populations, despite most of the total population demonstrating at least one indicator. In addition, all the clinical indicators that were present in the positive CT group were also present in the negative CT group. There were also several clinical indicators (seizures, altered mental status, irritability, lethargy and non-frontal scalp hematoma) that were only documented in the negative CT group.

These findings may indicate a need for change in diagnostic management among the youngest patients with MTBI. Among patients with clinical indicators, the risk of radiation exposure from a head CT may be warranted due to the risk of skull fracture or bleed. However, based on our findings, children without positive CT findings presented with clinical indicators. Other methods may need to be in place to limit radiation exposure. For instance, Atabaki et al.[18] noted that some predictors in isolation (severe mechanism of injury, loss of consciousness, vomiting, headache) have a lower risk for clinically important traumatic brain injuries and advocate observation before CT use in these cases. In addition, CT is standard protocol in child abuse cases for ages two and under and application of these indicators would not decrease head CT use in this series. In the current study, four known child abuse cases were identified.

One unique patient in the study had an initial negative head CT with observation of hemotympanum, and a follow-up CT that demonstrated a resolving subdural hematoma. However, this patient had fluid in the basilar air cells on the initial head CT, which should be considered as indirect evidence for a basilar skull fracture. This was the only patient in the study who demonstrated a false-negative finding based upon initial head CT scan. Regardless, this patient demonstrated two clinical indicators for head CT scan (severe mechanism and signs of basilar skull fracture), and the finding of hemotympanum on initial head CT scan would have prompted physicians to perform a repeat head CT scan for diagnosis.

There were several limitations to this study, foremost was its relatively small sample size. Second, the lack of follow-up information available after patients were discharged precluded knowledge of long-term outcomes following dismissal. Third, data regarding patients who did not undergo a cranial CT scan were not reported, therefore, an assumption was made that these patients were without significant cranial injury. Finally, since this was a retrospective chart review, there were known limitations of documentation. One example was the difficulty in obtaining a length of time for those patients experiencing a greater than five-second period of loss of consciousness. Although, loss of consciousness was found to be a frequent clinical indicator for head CT scan, the duration rarely was documented within the medical record, making it a difficult clinical indicator to use in the context of a retrospective study.

CONCLUSIONS

In the current study, most patients presented with at least one clinical indicator and most had a head CT scan. Severe mechanism of injury and signs of basilar skull fracture were more common for patients with a positive CT scan than patients with a negative CT scan. However, clinical indicators also were documented in patients with negative CT findings. This fact may indicate a need for change in diagnostic management among the youngest patients with MTBI.

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KANSAS JOURNAL of MEDICINE

Evaluation of Protective Equipment Used Among Motorbike Riders

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ABSTRACT

Introduction. This study compared outcomes between patients injured at a motorbike track, which requires riders to follow safety equipment guidelines, and those involved in recreational riding where safety equipment usage is voluntary.

Methods. A retrospective review was conducted of all patients presenting with motorbike-related injuries at an American College of Surgeons verified level-I trauma center between January 1, 2009 and December 31, 2013. Data collected included demographics, injury details, safety equipment use, hospitalization details, and discharge disposition. Comparisons were made regarding protective equipment usage.

Results. Among the 115 patients admitted, more than half (54.8%, n = 63) were injured on a motorbike track, and 45.2% (n = 52) were injured in a recreational setting. The majority of patients were male (93.9%), Caucasian (97.4%), and between the ages of 18 to 54 (64.4%). Helmet usage was higher among track riders (95.2%, n = 60) than recreational riders (46.2%, n = 24, $p < 0.0001$). Comparisons of injury severity and outcomes between those who wore protective equipment and those who did not were not significant.

Conclusions. Even though track riders wore protective equipment more than recreational riders, there was no difference between the groups regarding injury severity or hospital outcomes. These results suggested that motocross riders should not rely on protective equipment as the only measure of injury prevention.

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INTRODUCTION

Motocross is a high-risk endurance sport where off-road motorbikes (or dirt bikes) are put through challenging obstacles at high rates of speed.[1-11] This sport is particularly popular among males younger than 30 years, although in the United States (U.S.) children as young as four can compete, and the sport has begun to attract family participation.[1-7] Organized motocross events can occur in regulated arenas, but recreational motorbike use on unregulated private property is also popular.[1-16] Recent data from the National Electronic Surveillance System-All Injury Program (NEISS-AIP) from 2001-2004 indicated that 20% of off-road motorcyclists (≤ 19 years) treated for non-fatal injuries were from motocross areas, the remaining were from other off-road locations.[11]

The majority of injuries sustained by motocross participants include minor contusions and lacerations, however, more serious injuries such as extremity fractures and head injuries are also common.[1-12] In the U.S., motocross has the fourth highest incidence of head and neck injuries suffered by athletes who participate in extreme sports.[17] Recreational off-road motorbike riders experience similar injuries as riders in regulated events, yet these riders are also less likely to wear protective equipment.[12-16]

For racing in American Motocross Association sanctioned events, a full-face helmet is required which conforms to recognized Snell M2010 or Department of Transportation standards.[18] Additional safety equipment that also may be required includes shatterproof goggles, body armor, protective pants and long-sleeve jerseys, kneepads or braces, gloves, and boots. However, for recreational off-road activities, most states do not have safety regulations or requirements.[18,19] Consequently, the use of protective equipment is voluntary. Currently, Kansas has no restrictions on operator age, licensure requirements, helmet or eye protection regulations, or mandatory educational programs to operate motorbikes off-road.[19]

In the current study, outcomes associated with motorbike crashes were examined. Also, the types of safety equipment worn at the time of injury were identified. This study compared outcomes between patients injured at a motorbike track (who were more likely to have been required to follow equipment safety guidelines) and patients injured during recreational motorbike activities (where safety equipment usage is voluntary) to determine if safety equipment use in motorbike activities makes a difference in patient outcomes.

METHODS

A five-year retrospective chart review was conducted of all patients admitted with injuries sustained while operating a motorbike between January 1, 2009 and December 31, 2013. Eligible patients were identified through the trauma registry of an American College of Surgeons verified level-I trauma center. Patient's charts were reviewed to distinguish between an off-road motorbike and a standard motorcycle crash and to identify if the crash occurred at a local motocross track (TR) or on private property (RR). Recreational crashes were defined as those that occurred on private unpaved or other road surfaces. Track riders were defined as those who sustained an injury while riding on one of several local motocross tracks. Data collected included patient demographics, injury severity score (ISS), and crash details (crash type, location, and protective equipment worn). Details of the patient's hospitalization included hospital length of stay (HLOS), intensive care unit length of stay (ICU LOS), ventilator days, discharge disposition, and mortality.

All statistical analyses were conducted using SAS software for Windows, version 9.3 (Cary, North Carolina). Descriptive analyses were presented as means and standard deviations or median and interquartile range (IQR) for continuous variables, if the sample size was too small, along with frequencies and proportions for categorical variables. Continuous variables were compared using t-tests, and cat-

egorical data were compared using Chi-square analysis or the Fisher's exact test when appropriate. Patients were stratified by the crash location (track rider vs. recreational rider) and comparisons were made regarding protective equipment usage and hospital outcomes. In addition, a sub-analysis was conducted comparing the adult rider population (> 17 years of age) with the pediatric rider population (0 - 17 years of age). All tests were two-sided, and a p value < 0.05 was considered significant. This study was approved for implementation by the appropriate Institutional Review Boards.

RESULTS

A total of 115 patients were admitted for motorbike-related injuries. Most were male (93.9%, n = 108) and Caucasian (97.4%, n = 112) with an average age of 26.2 ± 13.4 years and ISS of 7.5 ± 6.1. Seventy-four patients (64.4%) were aged 18 - 54 and 31.3% (n = 36) were considered pediatric (Table 1). More than half of patients were injured on a motorbike track (54.8%, n = 63) and 45.2% (n = 52) were injured in a recreational setting. Almost one quarter (23.5%, n = 27) were admitted into the ICU, and 5.2% (n = 6) were on a ventilator. Most patients (90.4%, n = 104) were discharged home. An adult recreational rider with no protective equipment died of his injuries. There was no statistically significant difference between the study groups for demographics, hospital outcomes, and discharge destination.

Table 1. Comparison of demographics and hospital outcomes by treatment group.

	Total	Recreational Riders	Track Riders	P value
Number of Observations	115 (100%)	52 (45.2%)	63 (54.8%)	
Male Gender	108 (93.9%)	47 (90.4%)	61 (96.8%)	0.1505
Caucasian	112 (97.4%)	51 (98.1%)	61 (96.8%)	0.6752
Age Group				**0.0959**
Age 0 to 17	36 (31.3%)	11 (21.2%)	25 (39.7%)	
Age 18 to 54	74 (64.4%)	38 (73.1%)	36 (57.1%)	
Age 55 or older	5 (4.4%)	3 (5.8%)	2 (3.2%)	
ICU Admission, yes	27 (23.5%)	12 (23.1%)	15 (23.8%)	0.9265
Ventilation, yes	6 (5.2%)	3 (5.8%)	3 (4.8%)	0.8090
Hospital Disposition				**0.5643**
Home	104 (90.4%)	47 (90.4%)	57 (90.5%)	
Acute care or skilled nursing	1 (0.9%)	0 (0%)	1 (1.59%)	
Rehabilitation	9 (7.8%)	4 (7.7%)	5 (7.94%)	
Deaths	1 (0.9%)	1 (1.9%)	0 (0%)	

Comparison of protective equipment usage between the groups is presented in Table 2. The most common safety equipment reported for the total population was a helmet (73.0%, n = 84). Track riders were more likely to wear a helmet (95.2% vs 46.2%, p < 0.0001) and protective clothing (76.2% vs 15.4%, p < 0.0001) compared to recreational riders. No other protective equipment usage was documented in the RR group.

Table 2. Comparison of documented protective equipment status by treatment group.

	Total	Recreational Riders	Track Riders	P value
Number of Observations	115 (100%)	52 (45.2%)	62 (54.8%)	
Any Equipment, yes	84 (73%)	24 (46.2%)	60 (95.2%)	< 0.0001
Helmet, yes	84 (73%)	24 (46.2%)	60 (95.2%)	< 0.0001
Protective clothing, yes	56 (48.7%)	8 (15.4%)	48 (76.2%)	< 0.0001
Boots, yes	5 (4.4%)	0 (0%)	5 (7.9%)	0.0378
Neck, yes	4 (3.5%)	0 (0%)	4 (6.4%)	0.0644
Eyewear, yes	12 (10.4%)	0 (0%)	12 (19.1%)	0.0009

Comparisons based on protective equipment status and crash location are presented in Table 3. Regardless of crash location, those with documented protective equipment had the highest average ISS with the TR population being statistically significant. Patient HLOS varied among the RR and TR populations. For instance, RR without documented protective equipment had the longest HLOS (3.0 ± 3.8) while TR patients with protective equipment had the longest HLOS (3.2 ± 4.5), ICU LOS (median = 1, IQR = [1, 3]) and most ventilation days (median = 13, IQR = [3, 20]). However, there were no differences based on age, HLOS, ICU length of stay, and ventilation days.

A sub-population comparison among adult and pediatric riders demonstrated that most pediatric riders wore protective equipment and experienced a lower average ISS than the adult riders. Among the RR population who wore protective equipment, adults had the highest average ISS (10.0 ± 8.9) while pediatric riders had the lowest average ISS (4.7 ± 1.9) and the shortest average HLOS (1.8 ± 1.8). Among the TR population, adult riders with protective equipment had the highest average ISS (9.3 ± 6.9), and the longest average HLOS (3.8 ± 5.4). However, these results were not statistically significant (not shown).

Table 3. Comparison of injury severity, age, and hospital outcomes based on protective equipment status by treatment group.

	Recreational Riders				Track Riders			
	Combined	No Protective Equipment	Protective Equipment	P value**	Combined	No Protective Equipment	Protective Equipment	P value**
Number of Observations	52 (45.2%)	28 (53.8%)	24 (46.2%)		63 (54.8%)	3 (4.8%)	60 (95.2%)	
Injury Severity Score	7.7 ± 8.7*	7.3 ± 9.6*	8.3 ± 7.5*	0.6818	8.0 ± 6.08*	4 (3,4)†	8.3 ± 6.1*	<0.0001
Age	29.1 ± 14.0*	31.9 ± 13.8*	25.8 ± 13.9*	0.1142	23.8 ± 12.5*	21 (14,21)†	23.5 ± 12.2*	0.4109
Hospital Length of Stay	2.7 ± 3.1*	3.0 ± 3.8*	2.3 ± 2.0*	0.4229	3.1 ± 4.4*	2 (1,2)†	3.2 ± 4.5*	0.6575
ICU Admission, yes	12 (23.1%)	6 (21.4%)	6 (25%)	0.7606	15 (23.8%)	0	15 (25%)	NA
ICU Length of Stay	1 (1, 3.5)†	1 (1, 2)†	2 (1, 4)†	0.4712	1 (1, 3)†	NA	1 (1, 3)†	NA
Ventilation, yes	3 (5.8%)	3 (10.7%)	0	NA	3 (4.8%)	0	3 (5%)	NA
Ventilation Days	1 (1, 1)†	1 (1, 1)†	NA	NA	3 (3, 20)†	NA	13 (3, 20)†	NA

*All values were presented as mean ± SD.
** Calculation of ICU and ventilation days were based on those who utilized these services.
†All values presented as median (Q1, Q3) due to small number of cases.

DISCUSSION

Motorbike trauma patients in this study were most likely to be adults, Caucasian, and male, with more overall crashes occurring at motorbike tracks. The form of safety equipment most commonly worn by both groups was a helmet. However, recreational riders were less likely to wear helmets compared to riders injured on motorbike tracks, where safety equipment requirements are enforced. This finding was not surprising given evidence that without mandatory helmet laws, helmets are worn less frequently.[20,21]

Overall, most motorbike injuries in the current study were not severe. When compared to previous studies, the overall current RR population was injured less severely,[12-15] however, the TR population was injured more severely.[3,7,12] Regarding patient age, the most severely injured riders in the current study were adult riders who wore protective equipment, regardless of crash location. No severe injuries were found in the pediatric population, with RR pediatric riders who wore protective equipment having the lowest average ISS. Possible reasons for why the adult population had higher ISS than the pediatric population could be related to the nature of the crash, having a larger motorbike engine size, or participating in more risky behaviors.

Although the majority of the TR population in the current study wore protective equipment and the RR population did not, there were no statistically significant differences between the groups regarding injury severity and hospital outcomes. These results are consistent with various adult and pediatric motocross studies which demonstrated that despite protective equipment use motorbike riders still experienced a high rate of injuries.[1,2,4,5,7,8,12] For instance, a pediatric motocross study found 50% of patients sustained concussions and 69% orthopedic injuries, even though all patients wore full protective gear (helmets, goggles, protective pants, long-sleeve jersey, and boots).[1]

Based on these findings, other injury reduction measures such as focusing on risk factors that may be associated with increased injury rates are needed. Risk factors that may increase the chance of being injured while participating in motorbike activities include rider experience, hours of training, being under the influence of alcohol or drugs, size of motorbike engine, and speed and nature of the crash. For example, Colburn et al.[16] illustrated that jumping during motocross activities results in higher injury severity. This may explain why there were no differences between the two groups in our study since those injured on a track may have involved more jumps than those injured during recreational riding.

In addition, collisions and being run over by other riders may be more common for track riders than for recreational riders due to the proximity of other riders. In fact, Larson et al.[4] indicated that many severe injuries were related to collisions with other riders or as the result of being run over. However, due to the retrospective nature of this study, this information was not obtained. To understand the interplay between hospital outcomes and injuries resulting from motocross injuries, prospective studies are needed to define the circumstances that are involved in motocross crashes, including details on crash terrain and track design. Rider characteristics such as risk-taking behavior, rider experience and looking to see if riders with protective equipment are more likely to be involved in risk-taking behaviors than riders without protective equipment are also important.

In the current study, it would appear that protective equipment use during motocross activities is not warranted due to the lack of differences between those who did and did not wear protective equipment. However, the majority of injuries were not severe, and the mortality rate was low (0.8%) indicating that protective equipment use may have prevented more serious injuries. Further, we were unable to delineate critical descriptive data related to the rider's level of experience or characteristics of either the vehicle involved or the location where the accident occurred.

Helmet use is recommended for protection against severe head injuries and mortality.[15-17] Additional gear such as extremity protection and chest plates are encouraged due to the high rate of fractures and thoracic injuries.[1-12,14] Further, age restrictions and safety course/certification for minors, focusing on course designs, and requiring all participants to have protective gear fitted by a professional, should be implemented for all motorbike participants.[2,9]

There are limitations to this study. First, this study was retrospective and conducted at a single facility. The study was limited by a relatively small sample size and by the lack of consistent reporting of safety equipment in patient charts. Also, it was difficult to differentiate the specific type of two-wheeled vehicle utilized by the rider (e.g., a moped, motorcycle, motocross/recreational motorbike) based on patient charts. In addition, with the possibility of injured riders being admitted to another facility or being treated at the scene, not all motorbike- related injuries were represented in this study. Finally, it was difficult to distinguish from patient records whether participants injured on tracks were participating in sport versus riding recreationally.

CONCLUSIONS

In the current study, despite track riders wearing protective equipment more often than recreational riders, there were no differences in injury severity or hospital outcomes between these two groups. Accordingly, this study suggested that motocross riders should not rely on protective equipment as the only measure of injury prevention. Additional safety measures are needed such as policy changes and increased enforcement of existing standards.

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KANSAS JOURNAL of MEDICINE

Elastic Abdominal Binders Reduce Cesarean Pain Postoperatively: A Randomized Controlled Pilot Trial

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ABSTRACT

Introduction. A potential non-pharmacologic way to reduce postoperative pain and bleeding is using an abdominal binder during postoperative recovery. This study aims to determine the effect an elastic abdominal binder has on postoperative pain and hemorrhage after cesarean delivery.

Methods. A randomized, single-site, pilot trial was conducted at two prenatal care clinics and an academic hospital in Kansas. Beginning in April 2013, 60 patients were enrolled if delivering via cesarean. Participants were randomized to receive an abdominal binder or to a control group (did not use binder). Pain levels were reported by questionnaire one day after surgery using a 0 to 10 scale, with 10 being the worst pain. Patient characteristics and blood loss were assessed by medical record review.

Results. Of the 56 patients completing the study, 29 (51.8%) were randomized to the binder group and 27 (48.2%) were randomized to the control group. The binder group reported significantly lower pain score ($p = 0.019$) and average pain score ($p = 0.024$). There was no difference in body mass index, age, previous surgery, infant birth weight, estimated blood loss, and average dose of pain medication during the first 24 hours after the cesarean delivery between the two groups. There was no difference in pre- and post-operative hemoglobin levels by treatment group ($p = 0.406$).

Conclusions. Abdominal binders may be associated with improved postoperative pain scores but did not affect postoperative hemorrhage. ***Kans J Med 2018;11(2):48-53.***

INTRODUCTION

Postpartum hemorrhage after cesarean delivery is defined as a blood loss of greater than 1000 milliliters, a decline in hematocrit levels of 10%, or symptoms from blood loss necessitating a blood transfusion.[1-3] Primary obstetrical hemorrhages occur within the first 24 hours following delivery and are estimated to occur in 1 to 6% of all deliveries.[1,4,5] Postpartum hemorrhage continues to be the leading cause of maternal mortality worldwide and one of the top three causes of maternal death in the United States.[1,5,6] Hemorrhage that necessitates transfusion can lead to multiple infectious and non-infectious health problems.[7] Therefore, the avoidance of transfusion due to blood loss after surgery is ideal.

Postpartum patients delivering by cesarean are a unique subset of postoperative patients with specific risks and needs. Cesarean patients are in a unique situation in that they must care for a newborn infant immediately following surgery. Postoperative pain can affect the ability to sleep and lead to frequent nighttime awakenings, which can affect daytime functioning and maternal-infant interactions.[8,9] Women with greater pain are less likely to breastfeed. Although narcotics play an important role in postoperative pain control, there are potentially serious adverse reactions to these types of medications, such as opioid-related respiratory depression,[10] sedation, and pruritus.[11] Long-term use of narcotics may lead to gastrointestinal dysfunction like constipation and ileus/bowel complications.[12] In addition, postpartum patients need to ambulate early to reduce the risk of thrombosis.[10]

A potential non-pharmacologic way to reduce postoperative pain and diminish postpartum bleeding is with the use of an abdominal binder during postoperative recovery.[13] The binder is a soft elastic band, which attaches around the abdomen and adjusts to different abdominal circumferences by overlapping and attaching with Velcro. One theory regarding pain control is that an abdominal binder provides sufficient circumferential compression to reduce stress on the wound during transfers and ambulation. Another theory is that the binder provides sensory input when in contact with the skin, and that the sensory signals override the neural pathways carrying pain signals to the brain to some extent. The hemorrhage-prevention theory is that the mild pressure from the binder will assist the uterus to remain contracted as it begins the process of involution and provide mild tamponade of blood vessels in the wound.

Few randomized controlled studies reporting postoperative outcomes compared to a control group were found regarding use of abdominal binder after cesarean delivery. Cheifetz et al.[13] conducted a study which demonstrated the benefit of abdominal binders, in which patients who wore binders after major abdominal surgery reported unchanged pain and postoperative distress. Two randomized studies reported conflicting outcomes regarding use of abdominal binders for managing postoperative pain and blood loss after cesarean delivery. Gillier et al.[14] found no significant difference in pain between their two study groups on postoperative day one, although a slight, non-significant difference was noted postoperative day two. In contrast, Ghana et al.[15] found patients receiving abdominal binders reported less postoperative pain and less blood loss. Our randomized controlled trial aimed to evaluate the effect of abdominal binder use on postoperative pain and hemorrhage among patients undergoing cesarean delivery. We hypothesized that patients in the intervention group will report less postpartum pain, less volume of estimated blood loss, and less pain interfering with daily activities postpartum.

METHODS

This was a randomized controlled, single-site, pilot trial. The study was conducted at a teaching hospital in Wichita, Kansas with a goal of enrolling sixty patients over one year. The patients were recruited consecutively from two local clinics; one clinic was a private clinic and the other was a clinic staffed by resident physicians. This study was approved by two local institutional review boards and

has been registered on clinicaltrials.gov as a prospective randomized controlled trial with the identification number NCT01786330.

Women receiving prenatal care at either of the two clinics and planned to deliver via cesarean were eligible to participate in the study. Additional inclusion criteria included cesarean delivery at term (at least 39 weeks gestation) scheduled in advance, singleton gestation confirmed by ultrasound in the current pregnancy, aged 18 - 39 years old, were able to read and understand spoken English, and had a body mass index of 20kg/m2 to 40 kg/m2 pre-pregnancy or at the first prenatal visit.

Exclusion criteria included bleeding disorder or use of anticoagulants, methadone usage, abnormal placenta (placenta previa or placenta accreta), preoperative hemoglobin less than 10mg/dL, or chorioamnionitis (intrauterine infection). Patients that had chronic pain syndrome, defined as participating in formal chronic pain management within the past year, were excluded from the study. Two investigators reviewed each patient's eligibility, and obtained informed consent from the patient to participate in the study. A patient was excluded from the study if onset of labor occurred prior to the time when the cesarean was scheduled, or if the following complications developed during the cesarean: placental abnormality (placenta accreta, increta, or percreta), vasa previa, cesarean hysterectomy due to severe hemorrhage, or organ damage (cystotomy, enterotomy, ureteral injury).

After obtaining informed consent, one-to-one randomization was used to assign 30 women to the intervention and 30 women to the comparison group. A sample size of 30 per group was considered adequate for a pre-testing/feasibility study of such an intervention.[16,17] In regard to pain outcomes, the study was powered adequately for a reasonable improvement in pain scores. The following estimate was drawn from published results of the instrument for measuring the primary outcome for improving pain control, the Brief Pain Inventory-Short Form, in postoperative patients.[18-20] For the question about pain experienced "on average," the studies found pain scores of approximately 4 on the instrument's 0 - 10 scale, with a standard deviation of approximately 2. If the binder was associated with a drop in average pain score of 1.5 points on the scale, (i.e., a score of 2.5 in the intervention group versus 4.0 in the control group), there would be a statistically significant result with 30 participants per group using an alpha of .05 and power of 80%.[17] Research assistants generated the allocation sequence and randomization size, which were concealed to clinical investigators until interventions were assigned. Investigators enrolled eligible participants into the study, and research assistants assigned subjects to their respective groups. Random numbers were generated by computer in standard fashion and assigned by the research staff using IBM SPSS, Version 20, SPSS, Inc. (Chicago, IL).

Participants assigned to the intervention group received an elastic abdominal binder immediately postoperative and were instructed to wear the binder for the first 24 hours postoperatively. The women assigned to the control group received usual postoperative care, but agreed to data collection procedures associated with the study. In addition, the control group participants' physicians were allowed to prescribe a binder postoperatively if they believed one was indicated or upon patient request. Women in both study groups received pain medication as per the orders of their physicians.

A medical record review included the collection of the obstetrical information and reason for cesarean delivery. These variables include basic descriptive information about the pregnancy and delivery, such as the reason that the cesarean was scheduled in advance and the mother's age. Medications and dosages administered to the patient within the 24-hour postoperative period were collected and postoperative bleeding and pain outcomes were recorded.

Each participant completed a questionnaire at 24 hours postoperatively (Appendix A). The one-page questionnaire briefly addressed bleeding and pain control. Pain was assessed using the Brief Pain Inventory-Short Form.[21-23] On the questionnaire, the Brief Pain Inventory-Short Form was represented by items 3 - 8 with the exception of item 8d which was analyzed separately. Because patients normally do not perform work for pay or household work during the postoperative period, other investigators studying postoperative pain have deleted the item on pain interference with work from the Brief Pain Inventory-Short Form.[22] Instead, investigators modified the work interference item to capture a key aspect of the work of being a new mother, feeding the baby.

Postoperative blood loss was calculated as the difference between documented pre-operative hemoglobin concentration and postoperative hemoglobin concentration (lowest documented concentration during the hospital stay). Participants also were provided a bedside log to document pad use during the first 24 hours postoperative.

The primary outcome was postoperative pain, which was assessed using the Brief Pain Inventory-Short Form. The Brief Pain Inventory-Short Form is a widely-used instrument which has good psychometric properties in assessing pain in surgical patients.[21-23] The secondary outcome measure was postoperative blood loss by changes in hemoglobin concentration (difference between pre-operative hemoglobin concentration and lowest hemoglobin concentration documented postoperative). The number of pads used for vaginal bleeding and discharge during the postoperative period was tracked using a bedside log, which was completed by the participant.

Statistical Analysis

Data were analyzed using IBM SPSS, Version 20, SPSS, Inc. (Chicago, IL). Key continuous variables included number of pads used and the Brief Pain Inventory-Short Form subscale scores for pain severity and pain interference with function. Results for the intervention group versus the control group were compared using paired t-tests if the data were normally distributed and with Mann-Whitney tests if the data were skewed. Proportions were compared using Pearson's Chi-square or by Fisher's Exact tests when expected values in any cell were less than five. All statistical analyses were two-sided. P-value of less than 0.05 was considered statistically significant. An intention to treat analysis was conducted. Participants were analyzed in the group to which they were randomized.

RESULTS

There were 60 participants consented and randomized to either the control group or the intervention group (binder group). Of the 56 participants completing the study, 29 (51.8%) were randomized to the binder group and 27 (48.2%) were randomized to the control group. Four participants were excluded after randomization (Figure 1). Two participants crossed over to the binder group: one participant requested use of a binder and one participant was given a binder by medical staff. An intent-to-treat analysis was performed on 56 patients.

Demographics and clinical characteristics for participants completing the study are presented in Table 1. Indication for cesarean for most participants was previous cesarean (n = 50 of 56, 89.3%). Almost all participants received an epidural (n = 55, 98.2%). There was no difference in body mass index (BMI), age, previous surgery, infant birth weight, estimated blood loss, and average dose of pain medication during the first 24 hours after the cesarean delivery between the two groups. No statistically significant difference in the average dose of pain medication was found. There was also no difference in type of regional anesthesia used.

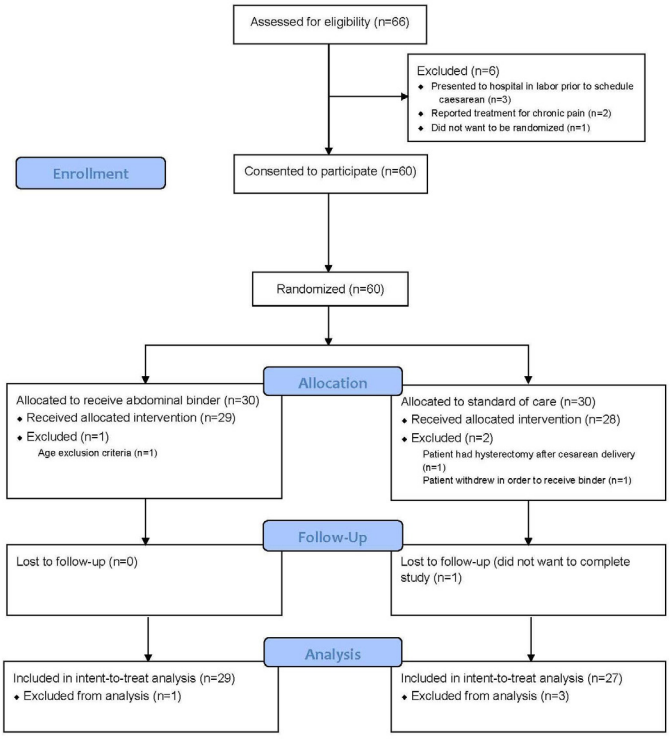

Figure 1. Flow diagram of participant randomization into trial.

Table 1. Patient demographics and clinical characteristics[a].

Characteristic	Binder (n = 29)	Control (n = 27)	P value
Age at cesarean (years)	28.5 ± 4.7	27.7 ± 4.4	0.420
Number of previous vaginal births, median (interquartile)	0 (0 - 0)	0 (0 - 0)	0.236
Number of previous cesarean deliveries, median (interquartile)	1 (0 - 2)	1 (1- 2)	0.354
Body mass index calculated during 1st visit	28.9 ± 6.6	28.6 ± 6.3	0.913
Gestational age at cesarean (weeks)	39.1 ± 0.3	39.3 ± 0.6	0.094
Infant birth weight (grams)	3632.5 ± 449.2	3525.2 ± 514.8	0.346
Reason for cesarean delivery			1.000
Previous cesarean delivery	26 (89.7%)	24 (88.9%)	
Breech presentation	3 (10.3%)	3 (11.1%)	
Received Epidural	28 (96.6%)	27 (100%)	1.000
Received Duramorph	29 (100%)	27 (100%)	1.000
Average Dose of Pain Medication (in milligrams) within the first 24 hours			
Hydromorphone hydrochloride (IV)	1 ± 0.71	0.92 ± 0.66	1.0000[b]
Morphine (IV)	6.11 ± 2.79	6.77 ± 3.95	0.5418
Nalbuphine hydrochloride	7.5 ± 2.67	11.43 ± 4.76	0.1054[b]
Acetaminophen/ hydrocodone	19.71 ± 10.39	17.42 ± 9.8	0.4783
Ibuprofen	888.89 ± 266.67	900 ± 282.84	1.0000[b]
Oxycodone[c]	22.5 ± 24.75	18.33 ± 18.93	
Oxycodone and acetaminophen[d]	11.67 ± 7.64	10 ± 0	
Ketorolac tromethamine	86.54 ± 17.65	86.79 ± 17.01	0.9584
Estimated blood loss (cc)	655.17 ± 183.39	668.52 ± 150.73	0.570
Number of pads used during 24 hours postoperative	5.29 ± 2.27	5.48 ± 1.95	0.381

[a]All values in Table 1 were presented as mean ± SD, interquartile range, or as the N (%) depending on the characteristics of the variable.
[b]P-value was calculated based on non-parametric Wilcoxon rank sum test due to small sample size.
[c]No p-value can be calculated due to only 3 patients in the binder group and 2 patients in the control group received Oxycodone.
[d]No p-value can be calculated due to only 3 patients in the binder group and 3 patients in the control group received Percocet.

On average, participants in the binder group reported significantly lower pain scores than participants in the control group. The average score of participants who responded "lowest level of pain felt postoperatively" was 1.66 ± 1.47 for the binder group and 2.56 ± 1.22 for the control group (p = 0.019; Figure 2). The binder group also reported significantly lower "average pain" scores, 3.45 ± 1.74 compared to 4.48 ± 1.60 for the control group (p = 0.024, Figure 2). "Worst level of pain" and "pain right now" also were lower among women receiving the binder treatment; however, results were not statistically significant. There was not a statistically significant difference in pain interference with activities like walking (Table 2). Pain interference with feeding the baby was lower among participants receiving the binder, with results nearing statistical significance (p = 0.078).

There was no difference in pre-operative to post-operative hemoglobin levels by treatment group, but participants in the binder group had a smaller change in hemoglobin levels preoperative to postoperative (p = 0.406; Figure 3). Binder group participants reported using 5.29 ± 2.27 pads compared to 5.48 ± 1.95 pads for the control group participants, but results were not statistically significant (p = 0.381). One patient in the control group received a transfusion.

In regards to adverse events or side effects in each group, two participants receiving the binder indicated that wearing the device for an extended period caused itching. There were no other side effects reported in either group.

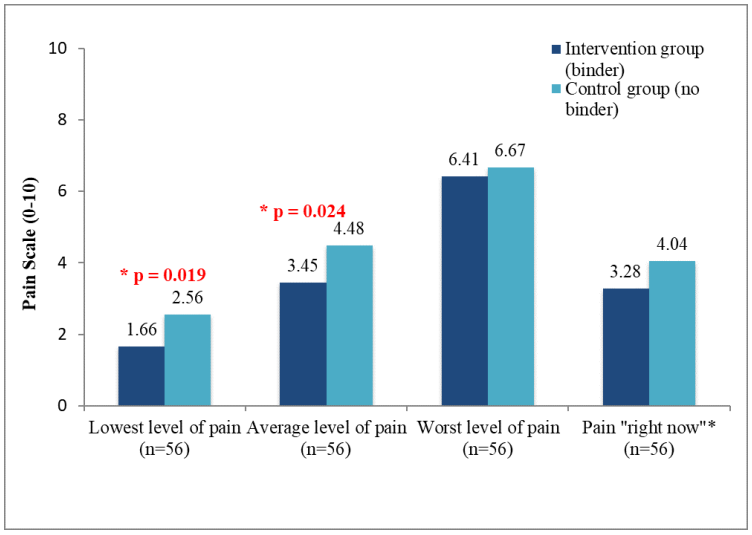

Figure 2. Average pain scores for lowest level of pain, average level of pain, worst level of pain, and pain at the time of assessment (24 hours postoperatively) as indicated by the control group (green) and the intervention group (blue).
*Larger value represents worse self-reported pain 24 hours after Cesarean.

Table 2. Postoperative pain assessment questions.

How Much Has Pain Interfered with Your:	Binder (n = 29)	Control (n = 27)	Both (n = 56)	P value
General Activity (missing = 2)	5.1 ± 3.1	4.9 ± 2.4	5.0 ± 2.7	0.767
Mood	2.0 ± 2.5	3.1 ± 2.8	2.5 ± 2.7	0.122
Walking Ability (missing = 4)	4.8 ± 3.2	4.6 ± 3.1	4.7 ± 3.1	0.747
Bonding with your Baby (missing = 1)	0.7 ± 1.3	1.7 ± 2.8	1.2 ± 2.2	0.295
Feeding your Baby (missing = 2)	0.7 ± 1.2	2.0 ± 2.8	1.3 ± 2.2	0.078
Relationships with other People (missing = 1)	0.9 ± 1.8	1.0 ± 2.2	1.0 ± 2.0	0.992
Sleep	3.7 ± 3.3	3.7 ± 2.5	3.7 ± 2.9	0.791
Enjoyment of Life	2.1 ± 2.7	1.9 ± 2.5	2.0 ± 2.6	0.959

*All values were presented as mean ± SD.
Pain was assessed using a visual analog scale, with 0 representing "Does not interfere" and 10 representing "Completely interferes."

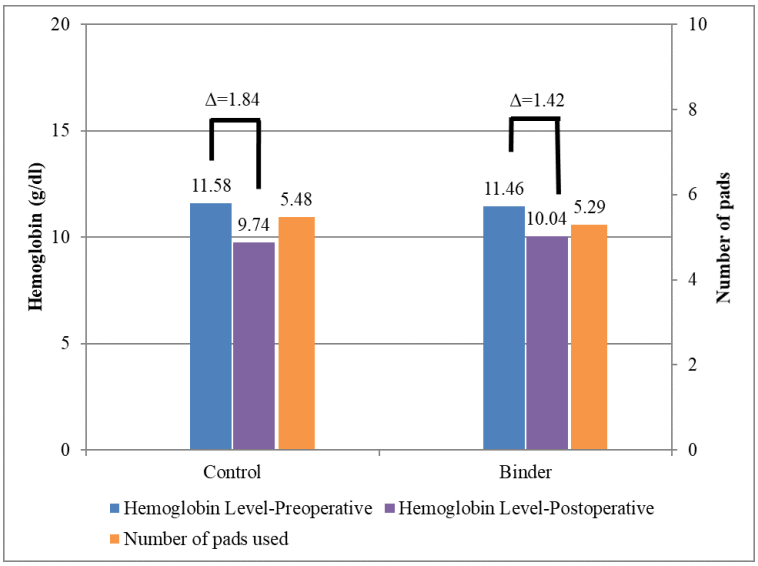

Figure 3. Average hemoglobin levels preoperative compared to postoperative levels, and number of pads used based on randomization group.

DISCUSSION

In this study, the use of an elastic abdominal binder significantly lowered average postoperative pain scores when compared to the control group. However, differences in hemoglobin concentrations before and after surgery were not statistically significant. There is also no significant difference in the number of pads used between the two groups.

Our results demonstrated that postoperative pain was improved with the abdominal binder. To account for the postoperative pain medication effect, the average dose of pain medication was compared between the intervention and control group. Our findings supported previous findings that an abdominal binder reduces postoperative

pain among patients going through major abdominal surgery,[13] and in regard to postoperative pain, our results were in agreement with the Ghana et al. study.[15]

Karlstrom et al.[9] reported that 78% of women in their study experienced pain greater than or equal to 4 on the Visual Analog Scale (VAS) during the first 24 hours after cesarean. Since pain may interfere with recovery and impede maternal-infant interactions, results suggested that an abdominal binder may alleviate patient pain during the first 24 hours following surgery. In our study, average pain reported 24 hours postoperatively among the binder group, was similar to the results found by Ghana et al.[15] In comparison, the patients in the control group in our study had lower average pain compared to their study control group. On postoperative day one, Gillier et al.[14] reported no difference in VAS scores regarding postoperative pain, but noted a slight difference in scores postoperative day two. However, in both instances, the abdominal binder group reported lower scores for both days, which was supported by our results that postoperative pain is lower among the abdominal binder group.

Our study found that, in general, pain did not interfere with maternal daily functions or activities postoperative regardless of treatment group. However, our study found that with the abdominal binder group, women reported lower pain interference when feeding and bonding with the baby. Although postoperative pain may not prevent a mother from feeding or bonding with the baby, women in greater pain are less likely to breastfeed.[8,9] Even though our study did not look at breastfeeding outcomes explicitly, it demonstrated abdominal binders may reduce pain so mothers can feed and bond with their newborns. Pain interfering with general activity and walking was slightly higher among binder patients, which is in contrast to findings by Cheifetz and colleagues that binders may improve mobility.[13] However, our patients reported pain interfering with general activity and walking in the 24-hour postoperative time, whereas Cheifetz's significant findings are reported on postoperative day five. Additionally, our patients may have reported pain interference that may be due to the actual compression and bulkiness of the abdominal binder, not the postoperative pain. Pain interference with postpartum activities should be investigated further, especially if binders improve breastfeeding initiation and mobility.

Change in hemoglobin concentrations and pad counts were not significantly different between the groups, suggesting that the binder did not have a significant effect on 24-hour postoperative blood loss. This was not surprising, since most blood loss in a cesarean is intraoperatively. Ghana et al.[15] found a statistically significant higher blood loss volume in their control group between baseline and 36 hours. Similarly, based on results from our study, the difference in hemoglobin concentration levels before and 24 hours after surgery were lower among women in the binder group, although not statistically significant. Furthermore, Ghana et al.[15] used a method presented by Shook et al.[24] to calculate blood loss based on estimated patient blood volume, and hematocrit levels measured preoperative and postoperative. We are unable to extrapolate on the postoperative blood loss using the pad counts, since estimated blood loss was not determined from the pads; however, we think pad use provides insight regarding blood loss in the postoperative period. Both our study and the Ghana et al. study provided estimates of postoperative blood loss, which should be investigated in future studies. Overall, there may be a possible benefit to binder use and postoperative blood loss at a longer duration postoperative, and this should be investigated further from a large sample size population.

The findings of this trial are generalizable to the population of pregnant women undergoing cesarean delivery; however, caution must be taken when interpreting the effectiveness of the abdominal binder. One limitation of this prospective randomized controlled trial was a smaller sample size and potential reporting bias due to inability to blind patients. Because of the small sample, we were unable to detect statistical significance between the control and intervention group on some important secondary outcomes, such as number of pads used during the first 24 hours postoperatively. Our study did not standardize or validate the level of pad saturation, we simply assumed that women changed their pad as necessary without determining the exact quantity of blood in the pad. Although the same type of pad utilized by our institution was used by all study participants, a future study may consider using a more accurate measure of postoperative blood loss, such as a measuring saturated pads or a menstrual pictogram. Additionally, postoperative hemoglobin concentration may have been reported in the electronic medical record at varying times, so we are unable to report an exact time for the postoperative hemoglobin concentration.

In addition to strengths commonly associated with randomized controlled trials, a strength of this study was limited loss of follow-up. A future study should aim to increase sample size, should consider utilizing validated qualitative measurements and estimations of postoperative blood loss, and determine pain medications used between treatment groups.

In conclusion, this study showed significantly improved lowest-reported pain scores and average pain scores among participants randomized to the treatment group (using the binder). Thus, the use of an abdominal binder may be a cost-effective, non-pharmacologic intervention to reduce postoperative pain after cesarean delivery.

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Keywords: Cesarean section, compression bandages, abdominal wall/surgery, postoperative pain, postpartum hemorrhage

CASE REPORT

Worse than the Disease? The Rash of *Lomatium Dissectum*

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INTRODUCTION

Influenza is a respiratory illness responsible for epidemic outbreaks of disease, and accounts for 500,000 to 1,000,000 emergency department (ED) visits in the United States each year.[1] Because of the high prevalence of disease and its potential morbidity, emergency physicians must be facile in its diagnosis and treatment. In addition, some treatments for influenza, such as neuraminidase inhibitors, are associated with a higher risk of symptoms, such as gastrointestinal and central nervous system effects, which themselves can prompt ED visits.[2] While front-line physicians have become adept at recognizing and managing both the symptoms of influenza and side effects of well-studied medical treatments, a further diagnostic challenge includes side effects of compounds or therapies recommended for influenza that are not well studied in Western medicine. Here, we present a report novel to the peer-reviewed medical literature of an adverse event due to the use of an herbal remedy for influenza.

CASE REPORT

A 74-year-old woman with a history of hypertension and coronary artery disease presented to the ED with a diffuse, intensely pruritic maculopapular rash of four days' duration (Figures 1 - 4). She visited her primary care physician three days prior to her ED visit, where she denied any medication changes, reporting only her longstanding use of hydrochlorothiazide, lisinopril, and clopidogrel, of which she had been on stable doses for a year. She also denied environmental or occupational exposures. Her primary care physician (PCP) prescribed a course of glucocorticoids, and when the rash continued to progress despite therapy, she was instructed to go to the ED. While the patient had denied new medications or exposures to her PCP, in the ED, it occurred to her that she had been exposed to an herbal supplement that she had not mentioned during her clinic visit. She recalled that the week previous to the development of her rash, she had experienced chills and cough, and had been diagnosed by a naturalist with influenza and advised to take an extract marketed as "LDM-100," an extract of *Lomatium dissectum*, a plant used as an herbal remedy for viral illnesses. She had taken this extract for two days as directed (six drops orally five times daily) when the rash erupted and continued taking it after the rash was present, but had stopped taking the extract the day before presentation to the ED because her cough and fever had resolved.

In the ED, a complete blood count, complete metabolic panel and inflammatory markers were unremarkable. It was deduced the *Lomatium dissectum* was the likely source of the rash, the patient was discharged home, and she elected to discontinue steroids. Five days after presentation, her symptoms had completely resolved.

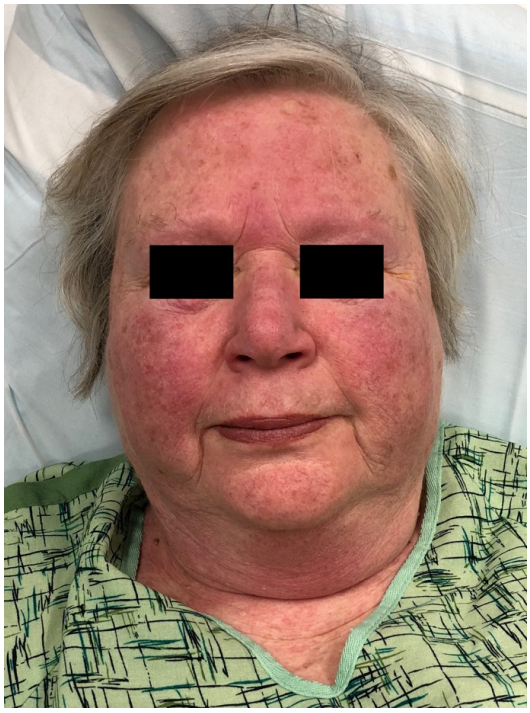

Figure 1. Facial rash.

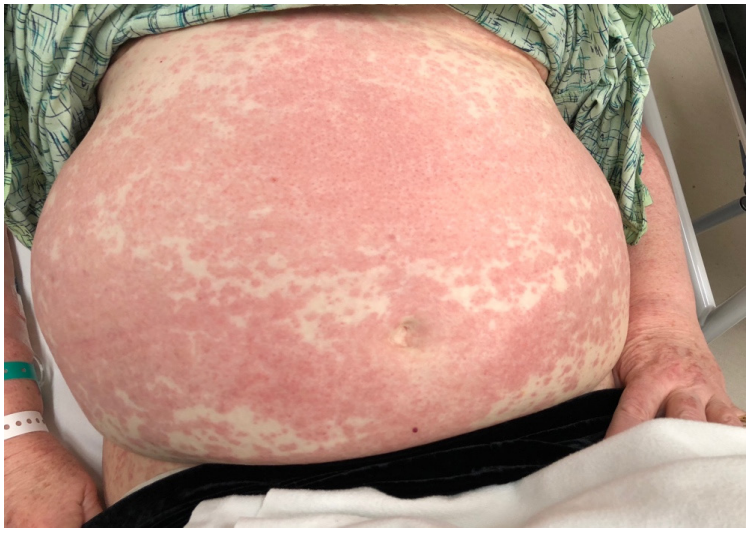

Figure 2. Abdominal rash.

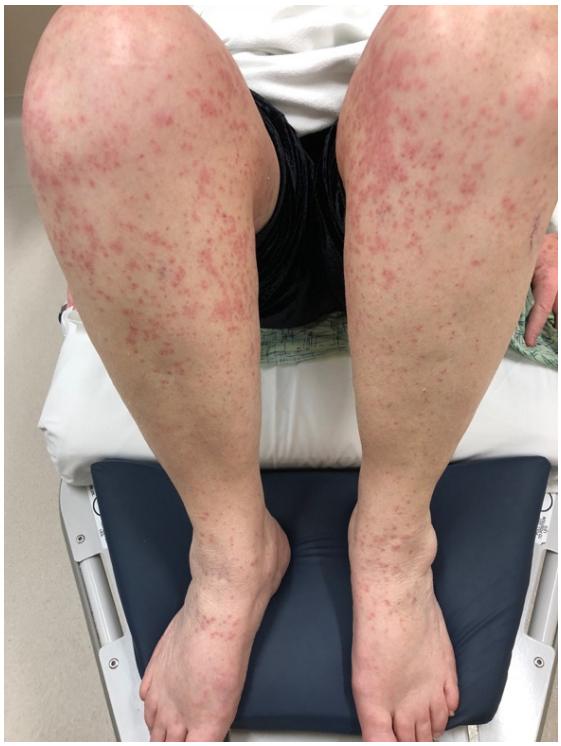

Figure 3. Rash of the leg.

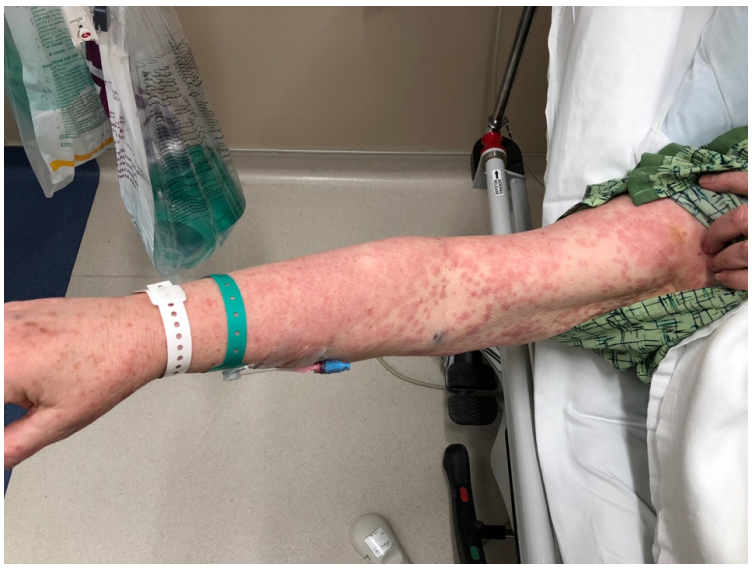

Figure 4. Rash of the arm.

DISCUSSION

Lomatium dissectum is a plant native to western North America and colloquially known as fernleaf biscuitroot.[3-5] It is commonly marketed as "LDM-100" and has gained popularity among practitioners of herbal medicine as a treatment against influenza. As evidence of its effectiveness, herbalists point to anecdotal experience of its use against influenza, its *in vitro* activity against other viruses such as rotavirus, and the observation that Native American populations using *Lomatium* during the influenza pandemic of 1917-18 had low rates of infection.[6,7] A side effect of the use of this plant that is known to the herbal medicine community is development of a pruritic, whole-body rash that appears within 1 - 3 days of initiating treatment with *Lomatium*, and generally resolves within 5 - 7 days of stopping exposure. Dosing regimens for *Lomatium* in the natural medicine community vary widely, from as few as three drops orally three times daily to 90 drops orally four times daily, with some sources suggesting that lower initial doses that gradually increase are less likely to cause rash.[5,8] Our patient's experience was consistent with this, as she started at a relatively generous initial dose, and the rash disappeared within five days of cessation. In addition to the preparation used by our patient, *Lomatium* can also be ingested as the unprocessed plant, used in teas, and also prepared in "isolate" form with the resins removed, which is a form alleged in some sources (without clear evidence) to be less likely to cause rash. The naturopathic literature from which most information about rashes caused by *Lomatium* is drawn do not indicate a well-studied treatment of the rash aside from supportive care and cessation of *Lomatium* ingestion. In our patient, the rash was refractory to glucocorticoids and only resolved once her exposure to the extract ceased, although antihistamines were helpful to reduce pruritis. A strategy of withholding *Lomatium* and focusing on symptom relief would seem to be a reasonable approach in similar cases.

Prior to this case report, there were no reports of this reaction to *Lomatium dissectum* in the peer-reviewed medical literature. Considering the likely continued use of *Lomatium* for influenza and other viral illnesses and the dramatic nature of the rash, physicians should be aware of this side effect.

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Metastasis of Benign Leiomyomas Outside the Uterus

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INTRODUCTION

Uterine leiomyomas affect up to 30% of reproductive-aged women and they represent the most common gynecologic neoplasm in females.[1,2] Diagnosis of classic uterine leiomyomata by radiology is not complex given their typical features on imaging and clinical manifestations. Ultimately, tissue diagnosis is definitive when leiomyoma is suspected on radiological imaging to distinguish it from leiomyosarcoma or other neosplasms. Leiomyomas are hormone-driven and most commonly arise from the uterus, but uncharacteristically can originate in the vulva, ovaries, bladder, and urethra.[3] In addition, on rare occasions, they have been discovered in the tissues of bone, deep soft tissues, skin, mediastinum, skeletal and cardiac muscle, lymph nodes, omentum, mesentery, and retroperitoneum.[4]

Metastasis of uterine fibroids are rare events and have been given such names as benign metastasizing leiomyoma (BML), intravenous leiomyomatosis (IVL), disseminated peritoneal leiomyomatosis (DPL), retroperitoneal leiomyomatosis (RPL), and parasitic leiomyoma (PL).[3] Multiple mysterious pulmonary nodules resulting from BML were first described by Marshall and Morris[5] and Steiner.[6] BML can be observed as a mass with histologically benign features, but also can demonstrate metastatic potential and present with diffuse lung tumors. This rare disease has gone by many titles. However, the current term, 'benign metastizing leiomyoma', represents a contraindication in the nomenclature. Steiner[6] recommended the use of the term "metastasizing fibroleiomyoma", as he thought the label of "benign" was incorrect.

Intravenous leiomyomatosis (IVL) is historically more rare than BML.[7] Even more of an oddity, IVL can extend into the cardiopulmonary system including the right atrium, right ventricle, and pulmonary arteries. When this extension of these lesions into the cardiac system is present, IVL is termed intracardiac leiomyomatosis (ICLM). In 1974, ICLM was first reported in English.[8] Likely due to technological advancements in imaging techniques, ICLM is being reported more often. However, definitive diagnosis is determined by postoperative pathological evaluation. IVL with cardiac extension is histologically benign. Thus, necrosis, mitoses, or cellular irregularities are rare.[9]

The tumors described above are typically benign entities, but uncommonly transition toward tissues of malignant potential. For two women who sought treatment for BML and IVL in our clinic, the primary goal was to outline and evaluate their specific genetic, pathological, and clinical features with the intention to elucidate possible treatment options.

CASE PRESENTATIONS

Case 1. A healthy, premenopausal, non-smoking, 30-year-old, Vietnamese woman with a negative family history of cancer was referred for multiple lung lesions. Two years prior, she underwent total hysterectomy for uterine fibroids. At that time, a single uterine fibroid was excised. Pathology confirmed a diagnosis of leiomyoma.

She initially presented with the chief complaints of flu-like symptoms and intermittent chest pain. Chest x-rays showed bilateral lung lesions. Bilateral breast mammograms showed no evidence of disease. Over the following years, the patient underwent an extensive outpatient workup, which included chest computed tomography (CT) scans and thoracoscopy, as well as bronchoscopy and bronchial washings, which proved to be unremarkable. Lung tissue biopsy was performed approximately nine years following the patient's hysterectomy. Lung biopsies revealed benign-appearing smooth muscle nodules. Pathology showed a low mitotic index. These findings, along with the absence of coagulative necrosis and atypia, suggested the diagnosis of BML.

Over the course of the next two decades, the patient was evaluated by multiple specialists. Her lung lesions persisted despite exhaustive regiments, including preliminary progesterone therapy. Megestrol, tamoxifen, and medroxyprogesterone were added to her therapy regiment. No toxicities from these medications were observed.

She was referred to M.D. Anderson Cancer Center. Leuprolide and letrozole recommendations were made for her uterine leiomyoma metastasis of the lungs. No curative therapy was identified. Being that it was nine years post-hysterectomy, additional lung lesion tissue was acquired. Immunostaining revealed full negativity to c-kit and Her2/neu, but mixed negative epidermal growth factor receptor (EGFR) results with slightly positive staining of material among muscle cells and not the muscle cells themselves. More recently, genomic sequencing by Foundation® testing was performed with patient blood samples. An ALK: N1532D variant of unknown significance (VUS) was discovered. The patient was being conservatively managed with observation and symptom management.

Case 2. A 33-year-old Caucasian woman of European descent presented to the emergency department with the chief complaint of abdominal pain. Ultrasound showed a large mass and follow-up CT scans revealed a pelvic mass. Surgical specialists performed a total hysterectomy and bilateral oophorectomy. At that time, a well-circumscribed mass was noted, solely adherent to the uterus and infundibulopelvic ligament. Pathology supported a diagnosis of leiomyoma. Serial sections of well-circumscribed right ovarian portions exhibited endometriotic cyst features, spindle cells without cytologic atypia, low mitotic activity, and absent malignant features. Spindle cell stromal growth predominated with similarities to fibromatosis (not otherwise specified).

Over time, the patient developed lung, cardiac, and intra-abdominal masses. Subsequent exploratory procedures revealed further gynecological tissue involvement, as well as retroperitoneal and extensive caval thrombus that extended bi-directionally into iliac veins and right atrium. At that time, approximately ten years post-hysterectomy, needle core biopsy of the intra-abdominal mass determined Müllerian origins, with benign smooth muscle features on histology. Immunostains of the tissue were negative for CD10, inhibin, S100, CD34, CD17, pancytokeratin CK7, and RCC. Desmin, actin, estrogen receptor, and WT-1 reacted positively, supporting a Müllerian origin. Emergent surgical intervention was considered.

Ultimately, caval thrombus mobilization, inferior vena cava reconstruction, total tricuspid porcine valve replacement, bipolar epicardial ventricular lead device placement (BEV), right radical nephrectomy, and removal of several large perirenal and retroperitoneal masses (> 5 cm) were performed. Samples from surgery were taken in all major areas. All tissue samples showed tumors made of spindle cells and absent necrosis and mitotic events. Ki67 testing showed a proliferation rate of less than 1%. Tissues with a vascular background were positive for CD34 (i.e., right atrium). Considering the patient's history, presentation, tissue histopathology, and symptom progressions, the etiology of her disease was determined to be most likely due to IVL. After the patient's multiple surgical interventions and stability were confirmed, she was discharged and followed as an outpatient. Recently, the patient's tumor tissue specimens were analyzed with the genomic sequencing assay Foundation® to determine if the etiology of this condition could be due to somatic and/or environmental mutations. Testing identified three variants of unknown significance: EGFR:V674I, ERBB4:K1002R, and TSC2:L826M.

DISCUSSION

Pathogenesis and Clinical Findings. Uterine leiomyomas are the most common gynecological tumor in women of reproductive age.[1,2] These tumors typically are benign entities but uncommonly can make transitions toward tissues of malignant potential. Rare growth patterns of uterine leiomyomata have been observed, which include BML, IVL, DPL, RPL, and PL.[3] The pathogenesis of these rare growth patterns is unclear. Furthermore, it remains uncertain which atypical growth pattern predominates over the others, due to all of their individual rarity. Based on the literature, BML, DPL and RPL has been observed to be more indolent.[3, 10-13]

In contrast, IVL has more aggressive characteristics.[9] The most common findings in patients diagnosed with BML are single or multiple subcentimetric lung nodules with or without a concomitant diagnosis of uterine fibroids, DPL, or IVL. The pathogenesis of BML is remains unclear. However, it has been postulated BML spreads hematogenously, originates from independent multiple foci, and/or is hormone-driven.[3, 10-13] Other atypical growth patterns that have been found to be hormone-driven include DPL, RPL, and PL. IVL has the unique feature of being incompletely hormone-driven. Clinical and pathological findings characteristic of IVL consist of in intraluminal growth in uterine and/or systemic veins, cord-like vessel lesions, and intracardiac extension, and tricuspid valve insufficiency.[3, 10-13]

The pathogenesis of these atypical growth patterns of uterine leiomyoma is unclear and controversial. These growth patterns are the result of clonal expansion of smooth muscle cells of the uterus, without significant cellular atypia or high mitotic index.[14, 15] In contrast, leiomyosarcomas frequently exhibit the higher turnover rates and atypia. In addition, they rarely are seen with frequency rates of 0.1 to 6%.[16] Primary lesions from these atypical growth patterns could be low-grade, slow growing leiomyosarcomas with inherently intact metastatic potential.[17] Also, erroneous sampling falsely could support the diagnosis of benignity.[18] However, recent cytogenetic studies have refuted this claim by showing that in contrast to leiomyosarcomas, these lesions have identical X-chromosome inactivation and a balanced karyotype.[19,20]

Metastasis of uterine fibroids most commonly appear several years after the diagnosis and removal of uterine leiomyomata by hysterectomy. Thus, prior gynecological surgery such as hysterectomy or myomectomy is a risk factor for developing any of these rare growth patterns that originate from benign uterine fibroids. In our two cases, the interval between uterine fibroid diagnosis, hysterectomy, and metastasis was two and zero years, respectively. Based on the review of literature, IVL appears to be less common phenomenon. An earlier report reviewing ten cases of BML observed an interval range of four to 23 years (mean 14.9 years) from the time of therapeutic hysterectomy to BML diagnosis.[17] The data remained consistent with preceding case review work that described the interval between hysterectomy to BML diagnosis that ranged from three to 20 years (mean 10 years).[6]

Genomic Sequencing. Genomic sequencing by Foundation® testing of blood and tissue samples from the patients in Cases 1 and 2 identified no genomic mutations in any currently established cancer-related gene. However, one variant of unknown significance (VUS) was detected in Case 1, ALK:N1532D, and three were detected in Case 2, EGFR:V674I, ERBB4:K1002R, and TSC2:L826M. In all samples from case patients, microsatellite status was determined to be stable and the overall tumor mutation burden was low (0.80 mutations/Mb).

These variants are termed as such because their alterations may not have been characterized adequately in the scientific literature at the time genomic sequencing was performed and/or the genomic context of these variants remains unclear. Thus, their clinical significance can neither be supported nor denied. Heightened VUS awareness poses a challenge to physicians not only for determining their relevancy, but for effectively communicating their importance to patients. Recent efforts have been made by National Center for Biotechnology Information (NCBI) to track and catalogue newly discovered variants with clinically relevant phenotypes.[21] We postulate that these variants could be targeted as treatment options in the future when patients have failed all other previous therapies.

Treatment. The benign versus malignant potential of BML and IVL remains unclear. Currently, there are no definitive guidelines regarding management due to their rare nature. BML is not only reliant on estrogen and progesterone, but also the majority of BML tumors are ER positive.[22] GnRH analogs have been successful in treating BML.[23,24] Progesterone antagonists have been discussed as possible adjuvant therapy for BML patients, but certain investigators advise against the use of these agents, at least not alone, because of their ability to up-regulate estrogen receptors.[25] Rivera et al.[26] believed anastrozole and raloxifene combination therapy could be as effective as the more traditionally used GnRH agonists and progesterone, even in postmenopausal patients with BML. Based on BML's close relationship to uterine leiomyomas, some investigators are optimistic raloxifene could be a suitable treatment option for BML. The literature is unclear on the effectiveness of tamoxifen on BML lesions.[23,26]

IVL with cardiac extension, such as with the patient in Case 2, has been described in the literature and termed intracardiac leiomyomatosis (ICLM).[8] ICLM is histologically benign. However, ICLM is suggested to be clinically aggressive due to the risk of sudden death caused by total outflow tract obstruction. Complete removal is the recommended treatment. Neoadjuvant and adjuvant anti-estrogen regiments or radiation therapy alone have not been shown to be a curative solution. This is due to the historical nature of IVL tumors to be incompletely hormone-driven. Finally, incomplete removal is not recommended due to previous studies reporting a near 30% recurrence rate if complete removal is not performed.[9]

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