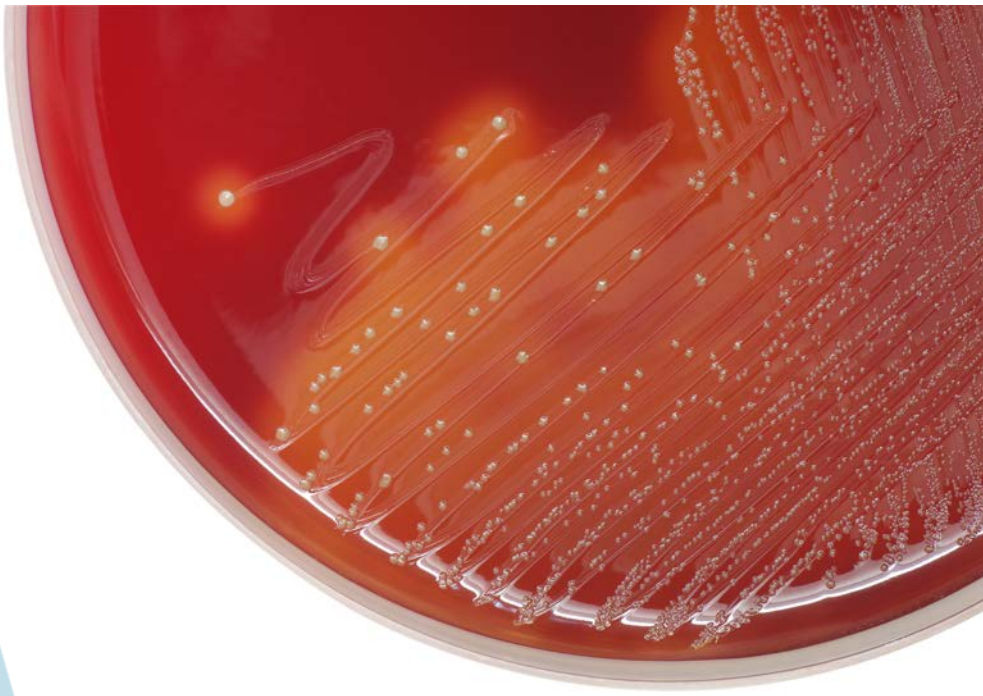
Public Health Ontario | Santé publique Ontario

Invasive Group A Streptococcal Disease in Ontario

2016-17 Seasonal Summary



Surveillance Report

May 2018

Public Health Ontario

Public Health Ontario is a Crown corporation dedicated to protecting and promoting the health of all Ontarians and reducing inequities in health. Public Health Ontario links public health practitioners, frontline health workers and researchers to the best scientific intelligence and knowledge from around the world.

Public Health Ontario provides expert scientific and technical support to government, local public health units and health care providers relating to the following:

- communicable and infectious diseases
- infection prevention and control
- environmental and occupational health
- emergency preparedness
- health promotion, chronic disease and injury prevention
- public health laboratory services

Public Health Ontario's work also includes surveillance, epidemiology, research, professional development and knowledge services. For more information, visit publichealthontario.ca.

How to cite this document:
Ontario Agency for Health Protection and Promotion (Public Health Ontario). Invasive Group A streptococcal disease in Ontario: 2016-17 seasonal summary. Toronto, ON, Queen's Printer for Ontario; 2018.

ISBN 978-1-4868-2008-5

ISSN 2561-6749

Public Health Ontario acknowledges the financial support of the Ontario Government.

Authors

Jennifer Pritchard, RN MPH
Nurse Consultant
Communicable Diseases, Emergency Preparedness and Response
Public Health Ontario

Michael Whelan, MSc
Epidemiologist Lead
Communicable Diseases, Emergency Preparedness and Response
Public Health Ontario

Maurice Coppin, RN, MN
Communicable Disease Consultant
Communicable Diseases, Emergency Preparedness and Response
Public Health Ontario

Kayla Burt, MSc(PH)
Health Analyst
Communicable Diseases, Emergency Preparedness and Response
Public Health Ontario

Karin Hohenadel, MSc
Manager
Communicable Diseases, Emergency Preparedness and Response
Public Health Ontario

Liane Macdonald, MD, MSc(PH)
Public Health Physician
Communicable Diseases, Emergency Preparedness and Response
Public Health Ontario

Acknowledgements

The authors wish to express their sincere appreciation for the effort and dedication demonstrated by Ontario's 36 public health units in iGAS case, contact and outbreak management and data collection and reporting. We also thank our colleagues at the National Microbiology Laboratory and the Toronto Invasive Bacterial Disease Network, for the important data they provide to support the work of public health units and Public Health Ontario. We would like to acknowledge staff within Knowledge Services and the laboratory at Public Health Ontario for their contributions to this report.

Disclaimer

This document was developed by Public Health Ontario (PHO). PHO provides scientific and technical advice to Ontario's government, public health organizations and health care providers. PHO's work is guided by the current best available evidence at the time of publication.

The application and use of this document is the responsibility of the user. PHO assumes no liability resulting from any such application or use.

Contents

Key Messages 1
Background 2
Objectives and Scope 3
Methods 3
Data Sources and Case Definition 3
Data Analysis 3
Results 5
Provincial Trends 5
Geographic Distribution 7
Age and Gender 11
Risk Factors 12
Complications 15
Hospitalization and Deaths 16
Emm type 18
Discussion 20
Limitations 22
Conclusions 22
References ..... **Error! Bookmark not defined.**
Appendix A: Technical Notes and Data Caveats 26
Appendix B: Number of cases with *emm* type by region 27

Key Messages

Provincial Trends

- In 2016-17, the rate of invasive Group A streptococcal disease (iGAS) in Ontario increased by 44.4% compared to the previous season (6.5 cases per 100,000 population versus 4.5 in 2015-16), continuing a decade-long trend. More cases were reported in the winter months and a higher proportion of cases were reported among males (54.0%).
- Rates of iGAS were highest in northwestern Ontario, which consists of Northwestern Health Unit and Thunder Bay District Health Unit, with 60.1 and 40.7 cases per 100,000 population, respectively.

Risk Factors

- The most commonly reported medical risk factor was chronic illness/underlying medical conditions (52.3% of cases reporting medical risk factor data); the most commonly reported behavioural risk factor was injection drug use (17.9% of cases reporting behavioural risk factor data).

Complications

- A similar proportion of complications and fatal cases were reported during the 2016-17 season compared to the previous five seasons. Although a slight increase in cases reporting hospitalization occurred in 2016-17, it does not appear that cases of iGAS were more severe than in the past.

Serotyping - *Emm* Type

- *Emm* type 1 remained the most frequently reported *emm* type among iGAS cases in Ontario (17.4%; 93/535) and *emm* type 74 emerged as a more commonly reported *emm* type with a 320.0% increase in the 2016-17 season compared to the 2015-16 season.

Background

Group A Streptococcal (GAS) disease is caused by the GAS bacteria.[1] These bacteria are often found in the throat or on the skin[1] and tend to cause mild infections like sore throat (referred to as "strep throat") and skin infections (e.g., impetigo or cellulitis).[2] Invasive Group A streptococcal infection (iGAS) occurs when the bacteria enter sterile parts of the body such as blood, deep tissue or the lining of the brain.[3] iGAS occurs much less frequently than milder, non-invasive, GAS infections of the throat and skin.[3] GAS bacteria have been found to have over 120 different serotypes or genotypes (*emm* types) based on specific M-protein serotypes or M-protein gene sequences.[2]

GAS bacteria are transmitted person-to-person through respiratory droplets or from direct contact with symptomatic people or carriers (people who are infected and have no symptoms of illness).[2,4]

iGAS cases tend to follow a seasonal pattern with reported case counts being highest from December to May before declining over the summer months then increasing again in the fall.[2,4] Individuals at increased risk for iGAS include:

- those with skin breakdown (e.g., burns, wounds, chickenpox)
- those with chronic underlying medical conditions (e.g., diabetes, immunocompromised)
- children less than one year and adults over 60 years old [2,3]
- people who use injection drugs[5]
- postpartum and postsurgical patients[6]

Severe life-threatening conditions, such as meningitis (infection of the lining of the brain and spinal cord), necrotizing fasciitis (sometimes referred to as "flesh-eating disease") and streptococcal toxic shock syndrome (involving low blood pressure and multi-organ impairment) can occur from an iGAS infection.[3] Necrotizing fasciitis and streptococcal toxic shock syndrome are the most severe presentations of iGAS disease and have mortality rates of 25-40% and 25% respectively.[2] In Canada, post-exposure antibiotic prophylaxis is recommended for close contacts of those with severe iGAS.[3]

iGAS is a nationally notifiable disease in Canada. Rates of iGAS in Canada have increased from 4.0 to 4.9 per 100,000 from 2009 to 2014.[7] Data indicate that the northern regions of Canada have higher incidence rates of iGAS compared to the rest of the country.[8]

Increases have also been reported in several provinces. In British Columbia (BC), between 2007 and 2016, rates increased from 5.7 to 6.4 per 100,000 population.[9] This is the highest rate in BC since the disease became reportable in 1997.[9] In the same time period, rates in Alberta increased slightly from 7.3 to 7.8 per 100,000 population.[10]

Locally in Ontario, several public health units reported increases in iGAS occurring in the community and affecting marginalized populations (e.g., people who use substances, people who live in homeless shelters or are under-housed) in 2016-17.[11-14]

Objectives and Scope

The objective of this report is to provide provincial-level information on reported cases of iGAS in Ontario in the 2016-17 season. It is intended to provide local public health units with a provincial view to contextualize their local analyses and investigations.

Using available data from Ontario's reportable disease surveillance system, this report describes confirmed iGAS cases from October 1, 2016 to September 30, 2017 by date, location, age and gender, complications, hospitalizations and deaths, and *emm* type. When appropriate, comparisons to historical data are provided. This report does not describe local trends or outbreaks in depth.

Methods

Data Sources and Case Definition

iGAS is reportable by designated groups such as laboratories, health care providers and administrators of hospitals. *Emm* typing for iGAS cases from Ontario is completed at the National Microbiology Laboratory and the Toronto Invasive Bacterial Diseases Network (TIBDN). iGAS data are reported to public health units and recorded in the integrated public health information system (iPHIS).

Case data for all confirmed cases of iGAS (as per the provincial case definition)[15] reported between October 1, 2006 and September 30, 2017 were extracted from iPHIS on January 23, 2018.[16] Data extracted for the previous five season's comparison analysis included cases with an episode date between October 1, 2011 and September 30, 2016. Annual population denominators were obtained from Statistics Canada (2006 to 2016), via IntelliHEALTH Ontario.[17]

Data Analysis

The number of cases and rate per 100,000 population for confirmed iGAS cases reported in Ontario were calculated on a seasonal basis from the 2006-07 season to the 2016-17 season. A season was defined as October 1 until September 30 of the next year. For example, cases with episode dates ranging from October 1, 2016 to September 30, 2017 were included in the 2016-17 season. When calculating rates, the population estimate for the first year in a season was used as the denominator. For example, in the 2016-17 season, the 2016 population estimate was used.

To determine if case counts by month in the 2016-17 season exceeded the expected number of cases, we plotted the number of cases by month for the 2016-17 season against the average case count for each month for the previous five seasons and the average plus two standard deviations.

Cases and rates were analyzed by public health unit. The rate per 100,000 population in the 2016-17 season was compared to the average rate of the previous five seasons. Additionally, the range of rates by public health unit for the 2016-17 season was divided into quartiles with an additional category for zero cases.

iGAS cases and rates were described by gender and age group for the 2016-17 season. The gender distribution by age group was calculated for the 2016-17 season and compared to the gender distribution by age group for the previous five seasons.

Risk factors, complications, symptoms, hospitalizations, deaths and *emm* type data were also extracted from iPHIS, where available, for the 2016-17 season and compared to the previous five seasons. Cases were determined to have had data reported for medical or behavioural risk factors respectively if the answer provided for any of the risk factors within the grouping was “Yes”, “No” or “Unknown”. Reported data from multiple iPHIS fields were recoded into complications variables of necrotizing fasciitis, necrotizing myositis, gangrene, meningitis, streptococcal toxic shock syndrome and soft tissue necrosis. The number and proportion of cases with identified risk factors and recoded complications for the 2016-17 season were calculated and compared to the previous five seasons where available.

The number and proportion of cases that were hospitalized and that were fatal were also calculated for the 2016-17 season and compared to the previous five seasons based on available information.

Emm type data were analyzed by geographic region for the 2016-17 season and the proportion of cases with *emm* type data reported was calculated by region (see Appendix B for geographic region definitions). *Emm* type data from the 2011-12 to 2015-16 seasons were also presented, with the top five *emm* types reported in each year highlighted. The change in frequency of reported *emm* type was calculated for the 2016-17 season compared to the 2015-16 season.

Data manipulation and analysis were conducted using SAS Enterprise Guide 7.1.

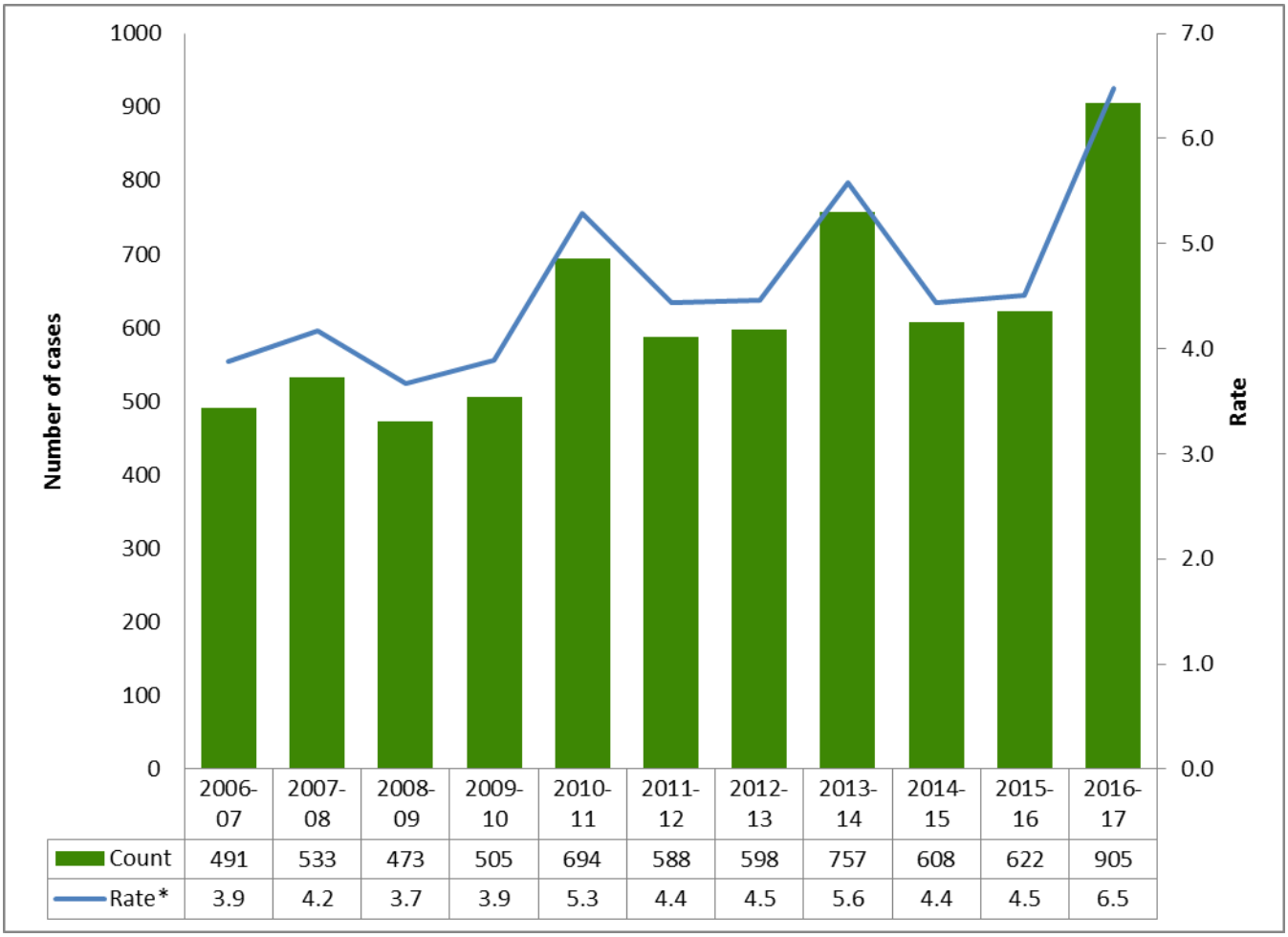
Please refer to Appendix A for further information regarding data caveats and technical notes

Results

Provincial Trends

Between the 2006-07 and 2016-17 seasons the rate of confirmed iGAS cases increased from 3.9 to 6.5 cases per 100,000 population, representing a 66.7% increase. Although rates fluctuate by year, since the 2006-07 season there is an overall increasing trend with distinct peaks every three years from 2007-08 (Figure 1).

Figure 1: Incidence of iGAS by season: Ontario, October 1, 2006 to September 30, 2017



	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Count	491	533	473	505	694	588	598	757	608	622	905
Rate*	3.9	4.2	3.7	3.9	5.3	4.4	4.5	5.6	4.4	4.5	6.5

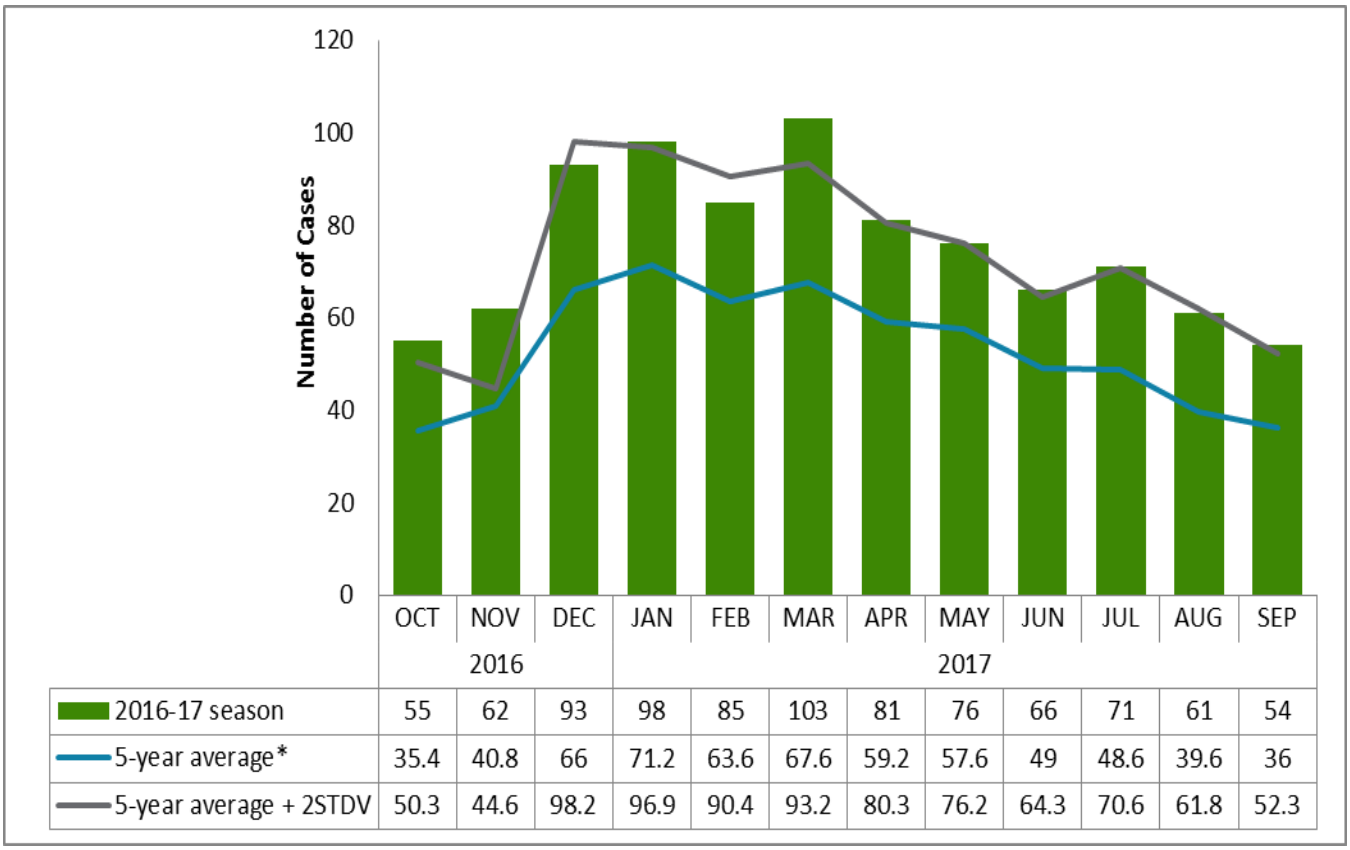
*Rate per 100,000 population

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. extracted [2018/01/23].

Ontario Population: Ontario. Ministry of Health and Long-Term Care, IntelliHEALTH Ontario. Population estimates 2005-2016. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2017 Jan 19].

During the 2016-17 season, 905 confirmed cases of iGAS were reported in Ontario. Similar to the previous five seasons, a higher number of confirmed iGAS cases were reported between December and May and a lower number of cases were reported during the summer and fall months. March had the largest number of confirmed iGAS cases reported in the 2016-17 season (103 cases), followed by January (98 cases) and December (93 cases). The number of iGAS cases reported in each month of the 2016-17 season was higher than the five year historical average. Additionally, the number of cases reported in eight of twelve months of the 2016-17 season exceeded the five-year historical average plus two standard deviations (Figure 2).

Figure 2: Confirmed cases of iGAS by month: Ontario, October 1, 2016 to September 30, 2017



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
	2016			2017								
2016-17 season	55	62	93	98	85	103	81	76	66	71	61	54
5-year average*	35.4	40.8	66	71.2	63.6	67.6	59.2	57.6	49	48.6	39.6	36
5-year average + 2STDV	50.3	44.6	98.2	96.9	90.4	93.2	80.3	76.2	64.3	70.6	61.8	52.3

*Five-year average based on 2011-12 to 2015-16 seasons

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Note: 2STDV is two standard deviations.

Geographic Distribution

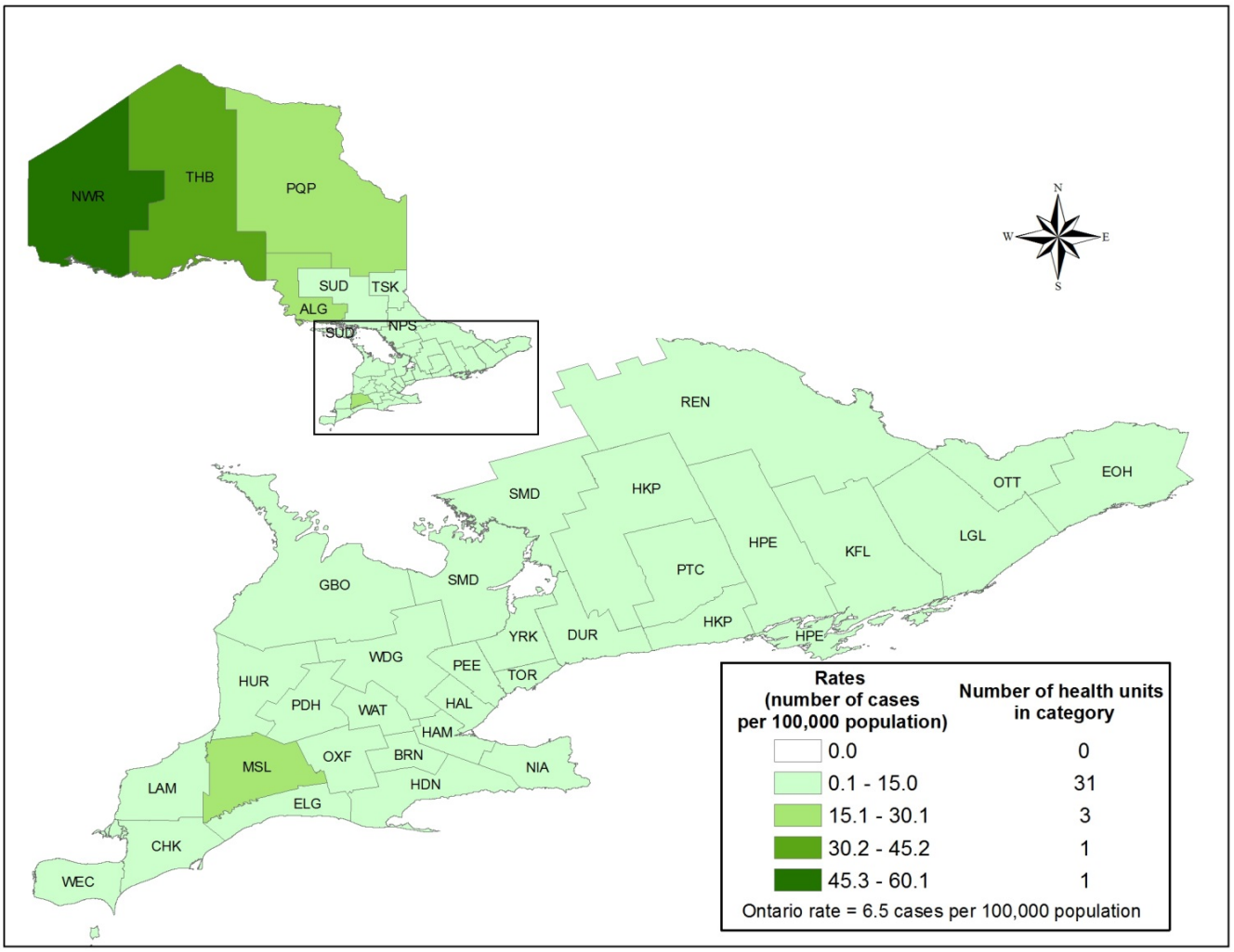
In the 2016-17 season, 44.4% (16/36) of public health units had rates above the Ontario rate of 6.5 cases per 100,000 population (Table 1).

The highest rates were reported in the northwestern public health units. Northwestern Health Unit had the highest rate, followed by Thunder Bay District Health Unit (60.1 and 41.7 cases per 100,000 population, respectively) (Map 1, Table 1). Similarly, the average rate in the previous five seasons (2011-12 to 2015-16) was also highest in the Northwestern Health Unit (36.4 cases per 100,000 population), followed by Thunder Bay District Health Unit (24.6 cases per 100,000 population) (Table 1).

Public health units in northeastern Ontario: Porcupine Health Unit and Algoma Public Health Unit, also had notably higher than average rates in 2016-17 at 18.8 and 18.2 cases per 100,000 population, respectively (Map 1, Table 1). In southern Ontario, Middlesex-London Health Unit had the highest rate at 19.8 cases per 100,000 population (Map 1, Table 1).

Leeds, Grenville and Lanark District Unit had the lowest rate during the 2016-17 season (2.4 cases per 100,000 population) (Table 1). Over the course of the previous five seasons, Huron County Health Unit had the lowest average rate at 2.3 cases per 100,000 population, but reported a rate of 6.8 cases per 100,000 population in the 2016-17 season.

Map 1: Incidence of iGAS by public health unit: Ontario, October 1, 2016 to September 30, 2017



Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Ontario Population: Ontario. Ministry of Health and Long-Term Care, IntelliHEALTH Ontario. Population estimates 2005-2016. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2017 Jan 19].

The Ontario rate in the 2016-17 season was 38.3% higher than the average rate for the previous five seasons. Algoma Public Health Unit and Middlesex-London Health Unit had the largest increases among Ontario public health units. Overall, when 2016-17 is compared to their previous five seasons, ten public health units had a reduced incidence rate and 26 health units had an increase in their incidence rate in 2016-17 (Table 1).

Table 1: Incidence of iGAS by public health unit: Ontario, 2016-17 season compared to previous five seasons

Public health unit	2016-17 season Rate per 100,000 population	2016-17 season Number of confirmed cases	Previous five seasons Average rate per 100,000 population	Previous five seasons Average number of confirmed cases	Percentage change 2016-17 season rate compared to previous 5 seasons
Northwestern Health Unit	60.1	49	36.4	29.6	65.1%
Thunder Bay District Health Unit	41.7	64	24.6	38.2	69.5%
Middlesex-London Health Unit	19.8	94	6.1	28.0	224.6%
Porcupine Health Unit	18.8	16	7.1	6.2	164.8%
Algoma Public Health Unit	18.2	21	5.0	5.8	264.0%
Sudbury and District Health Unit	12.5	25	7.9	15.8	58.2%
Brant County Health Unit	11.6	17	7.8	11.2	48.7%
Chatham-Kent Health Unit	11.4	12	6.2	6.6	83.9%
Elgin-St. Thomas Health Unit	9.9	9	3.5	3.2	182.9%
Niagara Region Public Health Department	9.3	42	4.2	18.8	121.4%
Haliburton, Kawartha, Pine Ridge District Health Unit	7.7	14	5.3	9.4	45.3%
Oxford County Public Health	7.1	8	4.5	5.0	57.8%
Lambton Health Unit	6.9	9	6.3	8.2	9.5%
Ottawa Public Health	6.9	67	4.6	43.2	50.0%
Windsor-Essex County Health Unit	6.9	28	3.2	13.0	115.6%
Huron County Health Unit	6.8	4	2.3	1.8	195.7%
Ontario	**6.5**	**905**	**4.7**	**634**	**38.3%**
Kingston, Frontenac and Lennox & Addington Health Unit	6.4	13	6.5	13.0	-1.5%
Eastern Ontario Health Unit	6.3	13	2.5	5.2	152.0%
Hastings and Prince Edward Counties Health Unit	6.1	10	5.1	8.4	19.6%
Hamilton Public Health Services	6.1	34	4.5	24.8	35.6%
Peterborough Public Health	5.7	8	5.3	7.4	7.5%
North Bay Parry Sound District Health Unit	5.5	7	7.3	9.4	-24.7%

Public health unit	2016-17 season Rate per 100,000 population	2016-17 season Number of confirmed cases	Previous five seasons Average rate per 100,000 population	Previous five seasons Average number of confirmed cases	Percentage change 2016-17 season rate compared to previous 5 seasons
Simcoe Muskoka District Health Unit	5.4	30	4.5	24.0	20.0%
Wellington-Dufferin-Guelph Health Unit	5.2	15	4.5	12.6	15.6%
Perth District Health Unit	5.1	4	6.7	5.2	-23.9%
Region of Waterloo, Public Health	4.9	27	4.9	26.2	0.0%
Grey Bruce Health Unit	4.9	8	5.5	9.0	-10.9%
Toronto Public Health	4.8	137	4.3	118.2	11.6%
Haldimand-Norfork Health Unit	4.5	5	3.6	4.0	25.0%
Renfrew County and District Health Unit	3.8	4	4.0	4.2	-5.0%
Durham Region Health Department	3.4	23	3.4	21.6	3.0%
Timiskaming Health Unit	3.0	1	5.2	2.3	-42.3%
Peel Public Health	2.7	39	2.8	38.8	-3.6%
Halton Region Health Department	2.6	15	3.5	19.0	-25.7%
York Region Public Health Services	2.5	29	2.8	30.6	-10.7%
Leeds, Grenville and Lanark District Health Unit	2.4	4	4.5	7.6	-46.7%

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Ontario Population: Ontario. Ministry of Health and Long-Term Care, IntelliHEALTH Ontario. Population estimates 2005-2016. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2017 Jan 19].

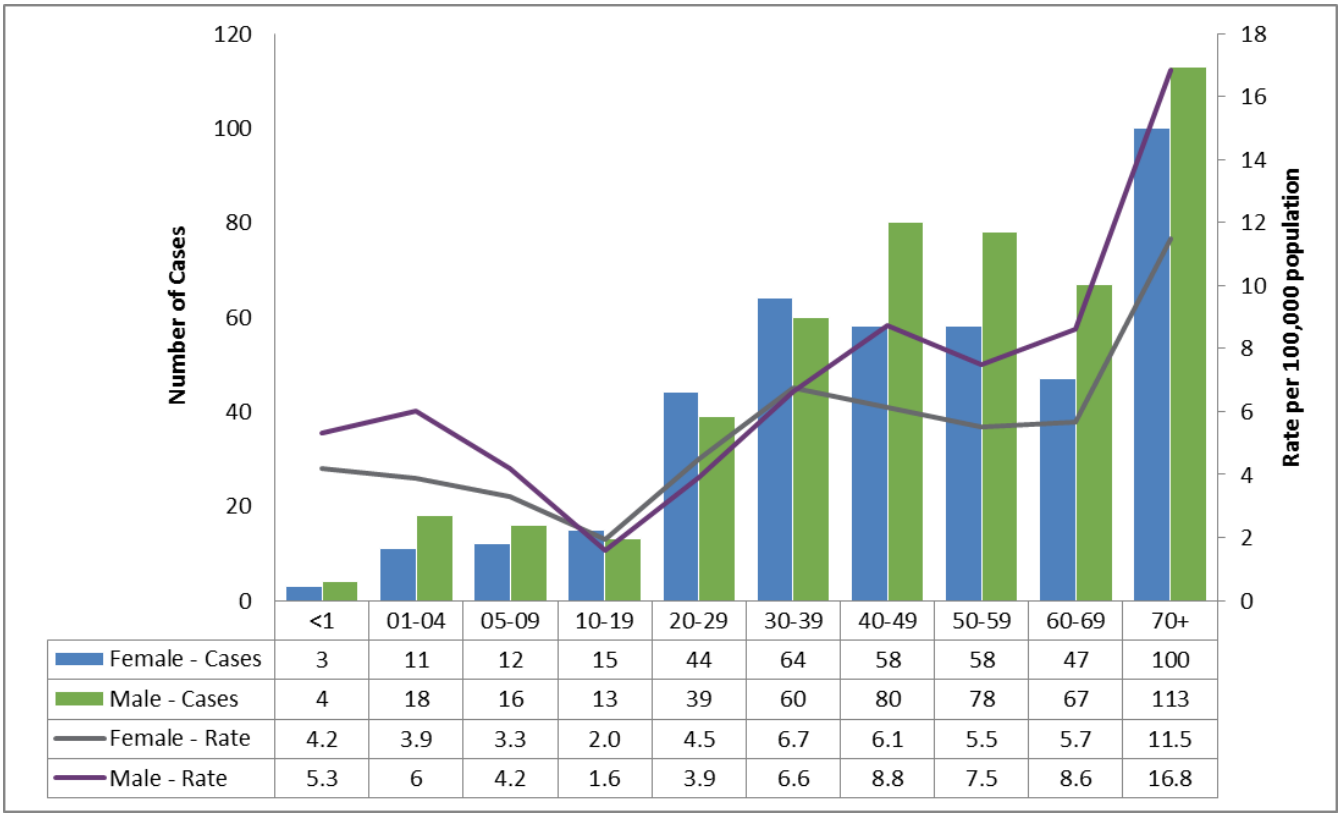
Age and Gender

During the 2016-17 season, the median age of cases was 51.3 years, with an age range from <1 to 101 years. There was a slight male predominance with 54.0% (489/905) of the reported iGAS cases occurring in males, 45.5% (412/905) of iGAS cases in females and 0.4% (4/905) of iGAS cases not specifying either male or female (Figure 3). Rates among males and females follow a similar pattern with the lowest rate being reported in cases 10 to 19 years of age (1.6 and 2.0 per 100,000 population, respectively) and the highest rate occurring in those greater than 70 years of age for both males and females (16.8 and 11.5 per 100,000 population, respectively).

During the 2016-17 iGAS season, males had a higher rate of iGAS in most age groups, except in age categories between 10 and 39 years where females surpassed males (Figure 3). This is a change from previous seasons where males made up a larger proportion of the iGAS cases reported in the 10 to 19 years age category (data not shown). Although females continue to account for a greater proportion of iGAS cases in the 20 to 29 and 30 to 39 age groups, the difference between males and females narrowed in these age categories in 2016-17 compared to the previous five seasons (data not shown).

The greatest difference in the distribution of confirmed iGAS cases by gender occurs in the cases one to four years of age, where males accounted for 62.1% (18/29) of cases and females accounted for 37.9% (11/29) of cases (Figure 3). This is a similar finding to that of the previous five seasons (data not shown).

Figure 3: Incidence of iGAS by age and gender: Ontario, October 1, 2016 to September 30, 2017



	<1	01-04	05-09	10-19	20-29	30-39	40-49	50-59	60-69	70+
Female - Cases	3	11	12	15	44	64	58	58	47	100
Male - Cases	4	18	16	13	39	60	80	78	67	113
Female - Rate	4.2	3.9	3.3	2.0	4.5	6.7	6.1	5.5	5.7	11.5
Male - Rate	5.3	6	4.2	1.6	3.9	6.6	8.8	7.5	8.6	16.8

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Ontario Population: Ontario. Ministry of Health and Long-Term Care, IntelliHEALTH Ontario. Population estimates 2005-2016. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2017 Jan 19].

Note: Four cases reported unknown gender; one case did not have an age reported.

Risk Factors

Medical Risk Factors

Information on medical risk factors (defined as having at least one medical risk factor with a response of "yes", "no" or "unknown") was captured for 92.5% (837/905) of iGAS cases reported during the 2016-17 season (Table 2). Chronic illness/underlying medical conditions was the most common medical risk factor, reported by 52.3% (438/837) of iGAS cases with medical risk factor information. Chronic illness/underlying medical condition was also the most frequently reported medical risk factor in the previous five seasons.

Table 2: Reported medical risk factors for confirmed cases of iGAS: Ontario, 2016-17 season compared to the previous five seasons

Risk factor, as captured in iPHIS	2016-17 Season Number of cases reporting "yes" for the medical risk factor*	2016-17 Season Percent among those with medical risk factor data reported*	Previous Five Seasons Average number of cases reporting "yes" for the medical risk factor	Previous Five Seasons Percent among those with medical risk factor data reported	Percentage change in the percent reporting medical risk factor data in 2016-17 compared to previous five seasons
Chronic illness/underlying medical condition, unspecified	438	52.3%	311.2	54.0%	-3.1%
Dermatological condition/chronic dermatitis/wound causing break in skin integrity	317	37.9%	185.4	32.2%	17.7%
Other	198	23.7%	110.4	19.2%	23.4%
Diabetes	162	19.4%	115	20.0%	-3.0%
Immunocompromised	136	16.2%	89.2	15.5%	4.5%

Risk factor, as captured in iPHIS	2016-17 Season Number of cases reporting "yes" for the medical risk factor*	2016-17 Season Percent among those with medical risk factor data reported*	Previous Five Seasons Average number of cases reporting "yes" for the medical risk factor	Previous Five Seasons Percent among those with medical risk factor data reported	Percentage change in the percent reporting medical risk factor data in 2016-17 compared to previous five seasons
Recent non-invasive strep infection	39	4.7%	21.6	3.7%	27.0%
HIV status (positive)	18	2.2%	5.8	1.0%	120.0%
Recent varicella infection (<1 month)	3	0.4%	3.2	0.6%	-33.3%
Unknown	108	12.9%	50.2	8.7%	48.3%
Total cases reporting data for one or more medical risk factors**	**837**	**92.4%**	**576.2**	**90.8%**	**1.8%**

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Table 2 Notes:

- *Note that the number and percentage will not add up to the total number of cases reporting a risk factor, as cases can have more than one risk factor entered into iPHIS.
- ** Includes responses of Yes, No, or Unknown for the risk factor in question.
- Free text entries were not reviewed for this report.

Behavioural Risk Factors

Information on behavioural risk factors (defined as having at least one behavioural risk factor with a response of "yes", "no" or "unknown") was captured for 86.5% (783/905) of iGAS cases reported during the 2016-17 season (Table 3). Similar to the previous five seasons, "unknown" was the most frequently reported behavioural risk factor in 2016-17, reported by 20.6% (161/783) of all iGAS cases. Injection drug use was the most frequently reported known risk factor during the 2016-17 season, reported by 17.9% (140/783) of cases, which was a 70.5% increase compared to the percent of cases reporting injection drug use during the previous five seasons. Similarly, the percentage increase in the percent of cases reported as being homeless/underhoused was 74.5%, going from 5.5% of cases in the previous five seasons to 9.6% of cases in 2016-17.

Table 3: Reported behavioural risk factors for confirmed cases of iGAS: Ontario, 2016-17 season compared to the previous five seasons

Risk Factor, as captured in iPHIS	2016-17 Season Number of cases reporting "yes" for a behavioural risk factor*	2016-17 Season Percent among those with behavioural risk factor data reported*	Previous Five Seasons Average number of cases reporting "yes" for a behavioural risk factor	Previous Five Seasons Percent among those with behavioural risk factors data reported	Percentage change in the percent reporting behavioural risk factor data in 2016-17 compared to previous five seasons
Injection drug use	140	17.9%	52	10.5%	70.5%
Other	105	13.4%	45.6	9.2%	45.7%
Alcohol abuse	98	12.5%	52.4	10.6%	17.9%
Homeless/underhoused	75	9.6%	27	5.5%	74.5%
Close contact with a case	21	2.7%	17.4	3.5%	-22.9%
Unknown	161	20.6%	86.6	17.5%	17.7%
Total cases reporting data for one or more behavioural risk factors**	**783**	**86.5%**	**495**	**78%**	**10.9%**

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Table 3 Notes:

- *Note that the number and percentage will not add up to the total number of cases reporting a risk factor, as cases can have more than one risk factor entered into iPHIS.
- ** Includes responses of Yes, No, or Unknown for the risk factor in question.
- Free text entries were not reviewed for this report.

Complications

Several severe conditions associated with iGAS were analyzed for the 2016-17 season and compared to the previous five seasons, these may represent complications or part of the spectrum of illness associated with iGAS (Table 4). The most common complication reported was streptococcal toxic shock syndrome, which was reported to have occurred in 11.9% (108/905) of iGAS cases during the 2016-17 season. Similarly, streptococcal toxic shock syndrome was the most frequently reported complication over the previous five seasons. Necrotizing fasciitis was the second most frequently reported complication during the 2016-17 with 9.2% of cases experiencing the complication. A similar proportion of iGAS cases in the previous 5 seasons reported necrotizing fasciitis.

Table 4: Reported complications for confirmed cases of iGAS: Ontario, 2016-17 season compared to the previous five seasons

Conditions	2016-17 Season Number of cases with each complication*	2016-17 Season Percent of cases with each complication	Previous Five Seasons Average number of cases with each complication**	Previous Five Seasons Percent of cases with each complication	Percentage change in percent reporting complication in 2016-17 compared to previous 5 season
Streptococcal toxic shock syndrome	108	11.9%	78	12.3%	-3.3%
Necrotizing fasciitis	83	9.2%	52.8	8.3%	10.8%
Soft tissue necrosis	63	7.0%	30.4	4.8%	45.8%
Meningitis	9	1.0%	4.4	0.7%	42.9%
Gangrene	8	0.9%	7.6	1.2%	-25.0%
Necrotizing Myositis	7	0.8%	4.2	0.7%	14.3%

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Table 4 Notes:

- *Cases can have more than one complication entered into iPHIS.

Hospitalization and Deaths

During the 2016-17 season, 84.3% (763/905) of iGAS cases were reported as being hospitalized, compared to 78.0% (2474/3173) of iGAS case hospitalizations in the previous five seasons (Table 5). Hospitalizations among iGAS cases were equally distributed between male and female cases. When comparing iGAS cases by gender, 82.0% (401/489) of male iGAS cases during the 2016-17 season were hospitalized. In the previous five seasons, 77.5% (1285/1658) of male cases were hospitalized. During the 2016-17 season 86.9% (358/412) of iGAS cases among females were hospitalized. This is an increase in the proportion of hospitalizations among female iGAS cases in comparison to the previous five seasons where 78.5% (1186/1510) of female iGAS cases reported hospitalization. The median age of hospitalized cases was 52.3 among males (range <1 years to 98 years) and 50.2 among females (range <1 years to 101 years).

Table 5: Reported hospitalization for confirmed cases of iGAS: Ontario, 2016-17 season compared to the previous five seasons

Gender	**2016-17 Season** Number of cases hospitalized	**2016-17 Season** Percent of cases hospitalized	**Previous Five Seasons** Average number of cases hospitalized	**Previous Five Seasons** Percent of cases hospitalized
Male	401	82.0% of male cases	257	77.5% of male cases
Female	358	86.9% of female cases	237.2	78.5% of female cases
Unknown	4	100% of cases with unknown gender	0.4	66.6% of cases with unknown gender
Total	763	84.3% of all iGAS cases	494.8	78.0% of all iGAS cases

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

A total of 91 cases (10.1%; 91/905) of iGAS were fatal during the 2016-17 season (Table 6). Although this is a larger number of deaths among iGAS cases compared to the average number of fatal cases over the past five seasons, the proportion of cases that died was similar to the previous five seasons (11.3%; 359/3173) (data not shown). iGAS was identified as the underlying cause of death in more of the deaths reported in the 2016-17 season (57.1% of deaths; 52/91) than in the previous five seasons (40.1% of deaths; 28.8/71.8) (Table 6). Among fatal iGAS cases during the 2016-17 season, 50.5% were female and 49.5% were male. The median age of fatal iGAS cases among females was 64.9 years (range10 to 94 years) and was 60.0 years (range 1 to 98 years) among males during the 2016-17 season (data not shown).

Table 6: Reported cause of death for confirmed cases of iGAS: Ontario, 2016-17 season compared to the previous five seasons

Cause of Death	2016-17 Season Number of fatal cases	2016-17 Season Percentof fatal cases	Previous Five Seasons Average number of fatal cases	Previous Five Seasons Percent of fatal cases
Reportable disease was underlying cause of death	52	57.1%	28.8	40.1%
Unknown	17	18.7%	8.4	11.7%
Reportable disease contributed to but was not underlying cause of death	16	17.6%	19	26.5%
Missing*	6	6.6%	15.6	21.7%
Total	91	100%	71.8	100%

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Table 6 Notes:

*Cases reported as fatal but no data for cause of death provided

Emm type

In the 2016-17 season, 59.1% (535/905) of iGAS cases had *emm* type data reported. Table 7 lists all iGAS *emm* types reported since the 2011-12 season by frequency and highlights the top five most commonly reported *emm* types for each season. The most commonly reported *emm* type since the 2011-12 iGAS season and during the 2016-17 season was *emm* type 1. Some *emm* types are consistently among the top five reported, such as *emm* 1, 12 and 89, while *emm* 74 and 81 have emerged and become commonly reported in past two seasons. Among *emm* types reported more than 12 times since the 2011-12 season, *emm* types 9, 41, 74, 81 and 91 all had increases of over 100% in 2016-17 compared to 2015-16.

Table 7a: iGAS *emm* types reported in Ontario: October 1, 2011 to September 30, 2017

Emm type	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Percentage change from 2016-17 compared to 2015-16	Total
1	**40**	**49**	**107**	**43**	**81**	**93**	14.8%	413
89	**31**	**26**	**34**	**20**	**26**	29	11.5%	166
12	10	**18**	**24**	**19**	**29**	**40**	37.9%	140
4	8	14	**18**	**27**	**27**	**35**	29.6%	129
81	0	3	2	8	**26**	**74**	184.6%	113
28	9	**21**	**20**	12	18	31	72.2%	111
3	**25**	13	11	13	19	14	-26.3%	95
74	0	1	0	0	15	**63**	320.0%	79
11	3	15	13	12	12	12	0.0%	67
6	6	**17**	11	5	10	15	50.0%	64
68	0	3	12	**22**	16	5	-68.8%	58
82	**25**	7	3	6	3	3	0.0%	47
101	6	8	14	0	7	3	-57.1%	38
87	**11**	8	4	6	6	3	-50.0%	38
2	1	7	9	10	5	5	0.0%	37
53	0	1	4	16	9	6	-33.3%	36
59	6	9	9	3	4	3	-25.0%	34
83	9	9	3	0	3	5	66.7%	29
75	7	3	4	5	4	4	0.0%	27
9	0	5	2	4	1	15	1400.0%	27
77	2	1	2	4	7	8	14.3%	24
118	4	4	9	1	3	2	-33.3%	23
41	3	1	2	2	4	9	125.0%	21
73	3	1	2	1	5	3	-40.0%	15
58	0	0	1	2	5	6	20.0%	14
91	0	0	0	0	3	11	266.7%	14
5	1	1	0	1	5	4	-20.0%	12
29	1	1	3	1	1	4	300.0%	11

Emm type	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Percentage change from 2016-17 compared to 2015-16	Total
80	1	3	2	1	2	2	0.0%	11
114	6	1	2	0	0	1	-	10
22	2	0	0	2	4	2	-50.0%	10
44	0	1	4	1	2	1	-50.0%	9
94	0	2	0	0	3	3	0.0%	8
92	2	2	2	1	0	0	-	7
18	0	1	0	0	2	3	50.0%	6
115	1	2	0	1	1	0	-100.0%	5
49	0	0	0	0	1	3	200.0%	4
76	0	0	1	1	1	1	0.0%	4
102	1	0	0	0	1	0	-100.0%	2
56	0	1	0	0	0	1	-	2
217	0	0	2	0	0	0	-	2
117	0	0	0	0	2	0	-100.0%	2
31	0	0	0	0	2	0	-100.0%	2
85	0	1	0	0	0	0	-	1
90	0	1	0	0	0	0	-	1
208	0	0	1	0	0	0	-	1
64	0	0	1	0	0	0	-	1
110	0	0	0	0	1	0	-100.0%	1
Total with 'other: Specify'	6	4	1	3	3	13	333.3%	30
Total cases with specified *emm* types	230	265	339	253	379	535	**41.2%**	**2001**
Total confirmed iGAS cases	588	598	757	608	622	905	**45.5%**	**4078**
Proportion of known *emm* types	39.1%	44.3%	44.8%	41.6%	60.9%	59.1%	**-3.0%**	**49.1%**

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

black shaded cells indicates the five most frequently reported *emm* types in each season

Discussion

Provincial Trends

The rate of iGAS in Ontario increased markedly in the 2016-17 season compared to the 2015-16 season, continuing a decade long trend. Examining this trend more closely, a pattern has emerged with peaks occurring every three years beginning in the 2007-08 season (Figure 1). Reasons for this increase are not fully understood and are likely multifactorial. Possible factors include the emergence of *emm* types infrequently reported in past, as well as changes in medical and behavioural risk factors and/or underlying determinants of health.[7,18]

During the 2016-17 iGAS season, March, January and December had the most cases of iGAS reported (Figure 2). Typically iGAS cases are reported more frequently in the winter months and fewer cases are reported in the summer months (Figure 2). This trend may be related to the transmission dynamics associated with iGAS, increased incidence of respiratory infections during the winter months,[16] increased amount of time spent indoors during the winter months and crowding among individuals with unstable housing.[2] The highest rates of iGAS reported in Ontario during the 2016-17 season were in northwestern Ontario (Map 1). Both the Northwestern Health Unit and Thunder Bay District Health Unit have noted increases connected to individuals with chronic illness/underlying conditions.[11,16] During 2017, the Thunder Bay District Health Unit identified the increase among those with a lack of adequate housing or those who use injection drugs whereas the Northwestern Health Unit identified the increase among those with dermatologic conditions, alcohol abuse and diabetes.[11,19]

Geographic Distribution

In southern Ontario, Middlesex-London Health Unit had the highest rate of iGAS for the 2016-17 season. In November 2017, the health unit issued an alert regarding an iGAS outbreak that had been ongoing for 18 months, with approximately 50 per cent of cases reported among people who are homeless/underhoused and/or people who use injection drugs.[12]

Age and Gender

During the previous five seasons, males account for a higher proportion of iGAS cases in all age groups, with the exception of the 20-29 and 30-39 age groups where female cases account for 57.5% of iGAS cases. The reason for this finding is not well understood, but it is possible this reflects an increased risk of iGAS infection for women during pregnancy or the postpartum period.[6] In the 2016-17 season, females also comprised a higher proportion of iGAS cases in the 10-19 age group. The cause of this variation is unknown. In older age categories, males make up a large proportion of iGAS cases; this could be related to the higher prevalence of co-morbidities, such as diabetes, among males than females[200] or variations in social or behavioural risk factors.

Risk Factors

Entry of medical and behavioural risk factor data ("yes", "no" or "unknown") in iPHIS improved in 2016-17 compared to the previous five seasons. Among cases that reported risk factor data, there was an observed increase in the proportion of cases reporting the risk factor "injection drug use" in the 2016-17 season, compared to the previous five seasons. Similarly, there was an increase in the proportion of cases reporting the risk factor "homeless/underhoused" in the 2016-17 season in comparison to the previous five seasons (Table 2). These increases could be related to a true increase in the burden of iGAS occurring among these populations (e.g., marginalized populations associated with outbreaks during the 2016-17 season), or the increase could be related in part to improved data collection and reporting.[11-13] It is interesting to note that there was a 33% decrease in cases reporting a recent varicella infection, which may be related to Ontario's universal varicella vaccination program.[21,22]

Complications

A similar proportion of complications and fatal cases were reported during the 2016-17 season compared to the previous five seasons (Table 4, Table 6). However, a higher proportion of cases were hospitalized in 2016-17 in comparison to the previous five seasons (Table 5). Although a slight increase in cases reporting hospitalization occurred in 2016-17, it does not appear that cases of iGAS were more severe than in the past. Improving data quality by classifying all cases in iPHIS as either severe or non-severe would help further characterize issues related to trends in disease severity in the future.

***Emm* Type**

Similar to previous iGAS seasons, *emm* types 1, 4 and 12 remain among the most commonly reported in Ontario. There were several *emm* types that underwent large increases during the 2016-17 season. *Emm* type 74 in particular emerged as one of the top five reported *emm* types in 2016-17 (Table 7). Similarly *emm* type 81 emerged in 2015-16 as one of the top five most reported *emm* types and remained one of the top five *emm* types in 2016-17 (Table 7). *Emm* types 9, 41 and 91 also underwent large increases in the 2016-17 season compared to the 2015-16 season but were still relatively uncommon (Table 7). The emergence of new *emm* types is known to occur and impact at risk populations; over time these *emm* types may become dominant or recede.[18] For example *emm* 59 was commonly reported in the late 2000s; it should be noted that it is infrequently identified in recent seasons.[23,24] Reasons for changes in circulating *emm* types associated with iGAS disease in the community are not fully understood, but may include a loss of virulence, replacement with a more virulent strain, or an increase in population immunity.[18]

Limitations

There are several data-related limitations that impact the ability to comprehensively assess the epidemiology of iGAS in Ontario. Non-invasive group A streptococcal (GAS) infections are not reported to public health. This makes interpreting increases in iGAS cases more challenging because to some degree these will be driven by the underlying burden of GAS infections, and we are unable quantify GAS trends based on data from iPHIS. We are also unable to determine to what degree improved case finding and health care provider reporting may explain the increase seen in cases during the 2016-17 season. Considering the severe nature of iGAS, improved case finding is unlikely to have a large impact on observed increases. iGAS reporting may be more dependent on health care provider reporting than other diseases reported to public health. Data completeness may be impacted by health care provider reporting, however due to the severity associated with iGAS this is unlikely.

Variation in the proportion of cases with data missing may impact the results for complications, hospitalization and deaths. There are also limitations in describing changes among risk factors between seasons as risk factor data is not entered for every case and the proportion of cases reporting medical and behavioural risk factors varies between seasons.

Overall, *emm* types were reported for less than 60% of iGAS cases in Ontario during the 2016-17 season. By geographic region, there is wide range in the proportion of cases with *emm* type data reported in Ontario (Appendix B). This variation in reporting *emm* types may limit the ability to analyze and report on geographical variation in circulating *emm* types.

Conclusions

In Ontario, the number of cases of iGAS has been increasing for at least a decade. Determining the cause of this increase is challenging and would benefit from data quality improvements in iPHIS, the exploration of linking public health surveillance data with other data sources, and additional research. iGAS continues to be experienced at higher rates in northwestern Ontario with a large number of health units in southern Ontario reporting a rate of less than 15 cases per 100,000 population. While iGAS *emm* types 1, 4 and 12 remain dominant among *emm* types reported, *emm* type 74 and 81 have emerged as top five reported *emm* types since the 2015-16 season. Most iGAS cases continue to require hospitalization, and in a minority of cases, severe complications or death continues to be reported. Although a slight increase in cases reporting hospitalization occurred in 2016-17, it does not appear that cases of iGAS were more severe than in the past.

References

1. Centers for Disease Control and Prevention. Group A streptococcal (GAS) disease [Internet]. Atlanta, GA: U.S Department of Health & Human Services; 2016 [cited 2018 Jan 24]. Available from: https://www.cdc.gov/groupastrep/diseases-hcp/index.html

2. Van Beneden C. Streptococcal diseases. In: Heymann DL, editor. Control of communicable diseases manual. 20th ed. Washington, DC: American Public Health Association; 2015.

3. Public Health Agency of Canada. Guidelines for the prevention and control of invasive group A streptococcal disease. CCDR. 2006;32S2:1-26. Available from: https://www.canada.ca/en/public-health/services/reports-publications/canada-communicable-disease-report-ccdr/monthly-issue/2006-32/canada-communicable-disease-report.html

4. Health Protection Agency, Group A Streptococcal Working Group. Interim UK guidelines for management of close community contacts of invasive group A streptococcal disease. Commun Dis Public Health. 2004;7(4):354-61.

5. Stockmann C, Ampofo K, Hersh AL, Blaschke AJ, Kendall BA, Korgenski K, et al. Evolving epidemiologic characteristics of invasive group A streptococcal disease in Utah, 2002–2010. Clin Infect Dis. 2012;55(4):479-87.

6. Prevention of Invasive Group A Streptococcal Infections Workshop Participants. Prevention of invasive group A streptococcal disease among household contacts of case patients and among postpartum and postsurgical patients: recommendations from the Centers for Disease Control and Prevention.Clin Infect Dis. 2002;35(8):905-9. Available from: https://academic.oup.com/cid/article/35/8/950/330363

7. Public Health Agency of Canada. National laboratory surveillance of invasive streptococcal disease in Canada: annual summary 2014. Ottawa, ON: Her Majesty the Queen in Right of Canada; 2015. Available from: https://www.canada.ca/content/dam/canada/health-canada/migration/healthy-canadians/publications/drugs-products-medicaments-produits/2014-streptococcus/alt/surveillance-streptococca-eng.pdf

8. Li YA, Martin I, Tsang R, Squires S, Demczuk W, Desai S. Invasive bacterial diseases in Northern Canada, 2006–2013. Can Comm Dis Rep. 2016;42(4):74-80.

9. BC Centre for for Disease Control. British Columbia annual summary of reportable diseases 2016 [Internet]. Vancouver, BC: Provincial Health Services Authority; 2017 [cited 2018 Jan 23]. Available from:http://www.bccdc.ca/resource-gallery/Documents/Statistics%20and%20Research/Statistics%20and%20Reports/Epid/Annual%20Reports/2016CDAnnualReportFinal.pdf

10. Interactive health data application – adjusted population estimates; 2016 Dec [Internet]. Alberta: Government of Alberta; [cited 2018 Jan 16]. Available from: http://www.ahw.gov.ab.ca/IHDA_

11. Northwestern Health Unit. Invasive group A streptococcus infections on the rise [Internet]. Kenora, ON: Northwestern Health Unit; 2017 [cited 2017 Dec 28]. Available from:

https://www.nwhu.on.ca/MediaPressCentre/Media%20Releases/NWHU%20Media%20Release%20-iGAS%20-%20Oct2017.pdf

12. Middlesex-London Health Unit. Ongoing invasive group A streptococcal (iGAS) disease outbreak prompts alert [Internet]. London, ON: Middlesex-London Health Unit; 2017 [cited 2017 Dec 28]. Available from: https://www.healthunit.com/news/invasive-group-a-streptococcal-disease-outbreak-prompts-alert

13. Thunder Bay District Health Unit. Increase of invasive group A strep [Internet]. Thunder Bay, ON: Thunder Bay District Health Unit; 2017 [cited 2017 Dec 29]. Available from: https://www.tbdhu.com/news/increase-of-invasive-group-strep-3

14. McIntosh E. Nineteen months later, Seaton House strep outbreak declared over. Toronto Star [Internet], 2017 Nov 6 [cited 2018 Mar 20]: News - GTA. Available from: https://www.thestar.com/news/gta/2017/11/06/nineteen-months-later-strep-outbreak-at-seaton-house-shelter-declared-over.html

15. Ontario. Ministry of Health and Long Term Care. Infectious disease protocol appendix B: provincial case definitions for reportable diseases disease: group A streptococcal disease, invasive (iGAS) [Internet]. Toronto, ON: Ministry of Health and Long Term Care; 2013 [cited 2013 Mar 20]. Available from: http://www.health.gov.on.ca/en/pro/programs/publichealth/oph_standards/docs/gas_cd.pdf

16. Ontario. Ministry of Health and Long Term Care. integrated Public Health Information System (iPHIS) as extracted by Ontario Agency for Health Protection and Promotion (Public Health Ontario). iPHIS Reportable disease trends in Ontario: iGAS illness rates and cases for all ages, for all sexes, in Ontario [Internet]. Toronto, ON: Queen's Printer for Ontario; 2017 [cited 2018 Jan 23].

17. Statistic Canada as distributed by Ontario. Ministry of Health and Long-Term Care, IntelliHEALTH Ontario. Population estimates 2005-2016, Ontario. Toronto, ON: Queen's Printer for Ontario; 2018 [extracted 2018 Jan 19].

18. Alaska Division of Public Health Section of Epidemiology. Outbreak of a rare subtype of group A streptococcus — Alaska, 2016–2017. State of Alaska epidemiology bulletin, recommendations and reports. 2017;19(2):1-10. Available from: http://www.epi.alaska.gov/bulletins/docs/rr2017_2.pdf

19. Northwestern Health Unit. Invasive group A streptococcus (iGAS) advisory [Internet]. Kenora, ON: Northwestern Health Unit; 2017 [cited 2018 Feb 20]. Available from: https://www.nwhu.on.ca/Audiences/Documents/Health%20Information%20Advisory%20-%20A%20streptococcus%20(iGAS).pdf

20. Kautzky-Willer A, Harreiter J, Pacini G. Sex and gender differences in risk, pathophysiology and complications of type 2 diabetes mellitus. Endocr Rev. 2016;37(3):278-316.

21. Patel RA, Binns HJ, Shulman ST. Reduction in pediatric hospitalizations for varicella-related invasive group A streptococcal infections in the varicella vaccine era. J Pediatr. 2004;144(1):68-74.

22. Wormsbecker AE, Wang J, Rosella LC, Kwong JC, Seo CY, Crowcroft NS, et al. Twenty years of medically-attended pediatric varicella and herpes zoster in Ontario, Canada: a population-based study. PloS one. 2015;10(7):e0129483. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4503773/

23. Tyrrell GJ, Lovgren M, St. Jean T, Hoang L, Patrick DM, Horsman G, et al. Epidemic of group A streptococcus M/emm 59 causing invasive disease in Canada. Clin Infect Dis. 2010;51(11):1290-7.

24. D'Souza C, Whelan M, Marshall S, Adinkrah L, D'Souza C. Proportion of invasive group A streptococcus (iGAS) by emm type in Ontario. Poster presented at: Toronto Invasive Bacterial Diseases Bacterial Network Education Day. 2010 Nov 19; Toronto, ON.

Appendix A: Technical Notes and Data Caveats

There are a number of caveats with respect to the data presented in this report, these are as follows:

- Case data:
  iPHIS is a dynamic disease reporting system which allows ongoing updates to data previously entered. As a result, data extracted from iPHIS represent **a snapshot at the time of extraction** and may differ from previous or subsequent reports.
  - The data for this report were based on information entered in the Ontario Ministry of Health and Long-Term Care, integrated Public Health Information System (iPHIS) database as of January 23, 2018.
- **Ontario Population data:**
  Population estimates 2005-2016. Ontario. Ministry of Health and Long-Term Care, IntelliHEALTH Ontario. Data extracted on October 19, 2017.
- The data only represent cases reported to public health and recorded in iPHIS. As a result, the counts are subject to **underreporting**.
- Case counts were assigned to PHUs based on the PHU of residence at the time of illness onset and not necessarily the location of exposure. Cases for which the case's PHU of residence was reported as MOHLTC (to signify a case that is not a resident of Ontario) or Muskoka Parry Sound (a health unit that no longer exists) were excluded.
- Cases are classified in iPHIS according to the (MOHLTC) surveillance **case definitions,** available online as part of the Infectious Diseases Protocol (for details, please see the provincial iGAS case definition). Please note that the case definitions available online represent the most recent versions and cases reported in prior years may have slightly different case definitions.
- Cases in this dataset are reported based on the earliest of 'Episode Date' or 'Reported Date' to correct for potential data entry irregularities. In order to determine 'Episode date', the following hierarchy is used for iPHIS data entry depending on which date is available: Onset Date > Specimen Collection Date > Lab Test Date > Reported Date.
- Cases for which the 'Encounter Status' was reported as ENTERED IN ERROR, DUPLICATE-DO NOT USE, or any variation on these values were excluded.
- Risk factors were based on information reported in iPHIS and may not be fully captured for every case.
  - Cases may have multiple risk factors reported, no hierarchy was applied to these data, and each risk factor was kept for the analyses.
  - Cases were determined to have risk factor data reported if responses of yes, no or unknown were provided for any risk factor in the medical risk factors category and the same approach was taken for the behavioural risk factors.
- In 2011, a user guide was released to aid with the entry of risk factor data into iPHIS. Some risk factor variables were added at this time or renamed. These changes make comparisons of risk factor data before and after the release of the guide difficult.

Appendix B: Number of Cases with *Emm* Type by Region

Geographic Region	Number of cases with *emm* type specified	Number of cases by region	Proportion of regional cases with *emm* type specified
South West	106	176	60.2%
North West	100	113	88.5%
Central West	97	155	62.6%
Eastern	82	111	73.9%
Toronto	62	137	45.3%
Central East	51	143	35.7%
North East	37	70	52.9%
Overall	535	905	59.1%

Ontario Cases: Ontario. Ministry of Health and Long-Term Care. Integrated Public Health Information System (iPHIS) [database]. Toronto, ON: Queen's Printer for Ontario; 2018 Jan 10 [extracted 2018 Jan 23].

Central East

- Durham Region Health Department
- Haliburton, Kawartha, Pine Ridge District Health Unit
- Peel Public Health
- Peterborough Public Health
- Simcoe Muskoka District Health Unit
- York Region Public Health Services

Central West

- Brant County Health Unit
- Haldimand-Norfolk Health Unit
- Halton Region Health Department
- Hamilton Public Health Services
- Niagara Region Public Health Department
- Region of Waterloo, Public Health
- Wellington-Dufferin-Guelph Health Unit

Eastern

- Eastern Ontario Health Unit
- Hastings And Prince Edward Counties Health Unit
- Kingston, Frontinac Lennox & Addington Health Unit
- Leeds, Grenville and Lenark District Health Unit
- Ottawa Public Health
- Renfrew County And District Health Unit

Northeastern

- Algoma Public Health Unit
- North Bay Parry Sound District
- Porcupine Health Unit
- Sudbury And District Health Unit
- Timiskaming Health Unit

Northwestern

- Northwestern Health Unit
- Thunder Bay District Health Unit

Southwest

- Chatham-Kent Health Unit
- Elgin-St. Thomas Health Unit
- Grey Bruce Health Unit
- Huron County Health Unit
- Lambton Health Unit
- Middlesex-London Health Unit
- Oxford County Public Health
- Perth District Health Unit
- Windsor-Essex County Health Unit

Toronto

- Toronto Public Health

Public Health Ontario
480 University Avenue, Suite 300
Toronto, Ontario
M5G 1V2

647.260.7100
communications@oahpp.ca
www.publichealthontario.ca