

# How Many Grays to Get to the Malfunction of an Insulin Pump?

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# How Many Grays to Get to the Malfunction of an Insulin Pump?

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## INTRODUCTION

- Insulin pump manufacturers state in user guides that insulin pumps must be removed prior to any form of radiation exposure.
- However, the research on insulin pump exposure to radiation is lacking.
- The user guide recommendations are not based on researched data, rather just assumed precautions to protect the patient from possible insulin pump malfunction.
- Removal of insulin pumps can lead to hyperglycemia and even diabetic ketoacidosis, a potentially life-threatening complication of diabetes mellitus.

## OBJECTIVES & METHODS:

- The primary objective is to determine if exposure to a documented amount of radiation has an effect on insulin pump function.
- Donated insulin pumps, new Medtronic (models 523 and 630g) and Animas (both Ping models; one new, one a demonstration model) brands, were filled with saline and set to identical program modes.
- They were attached together by rubber bands with a dosimeter and exposed to repeat CT scans for radiation exposure.



Figure 1: Insulin pump arrangement during radiation.

Table 1. Pre-programmed Modes of Insulin Pumps

Basal Settings		Bolus Settings	
Total	24 units/day		
12 am	0.80 units	Carb Ratio	1:10
3 am	1.20 units	Sensitivity	45
6 am	1.00 units	BG Target	110-130 (+/-10)

## RESULTS:

- The older Animas insulin pump had one “Prime” alarm during CT scan radiation exposure as well as a darkened screen; this pump was removed from further radiation exposure after 6 CT scans.
- Medtronic pumps (models 523 and 630g) and new Animas pumps all continued to receive 34 more consecutive CT scan exposures with no significant alarms, failures, or malfunctions.
- Medtronic 630g pump experienced “Low Battery” and “Stuck Button” alarms, both of which were easily fixed without complications.
- The three insulin pumps received a total of 8,612 mRem throughout the 34 repetitive CT scans.
- The initial Animas insulin pump was monitored and continued to function for 2 months following the radiation exposure
- The other three insulin pumps continued to function during the remaining radiation exposure as well as for the 2 months following radiation exposure while they were monitored.

Table 2. CT Scan Radiation Exposure Raw Data Collection

CT SCAN #	DATE	TYPE OF CT	PUMP TIME	CONTRAST?	ALARMS (Y/N?)	ALARM	SETTINGS
1	5/10/17	abd/pelvis	3:40pm	without	no		ok
2	5/10/17	abd/pelvis	3:52pm	with	no		ok
3	5/10/17	abd/pelvis	4:04pm	without	no		ok
4	5/22/17	abd/pelvis	11:25am	without	no		ok
5	5/22/17	abd/pelvis	11:43am	with	YES - Animas	Prime Alarm	ok
6	5/22/17	abd/pelvis	2:25pm	with	no		ok
NEW	PUMPS	ADDED	HERE!!!				
7	7/26/17	head/Cspine	9:50am	without	no		ok
8	7/26/17	head	10:24am	without	no		ok
9	7/26/17	head	10:35am	without	YES - New Medtronic	Low Battery	ok
10	7/26/17	chest	10:54am	with	no		ok
11	7/26/17	chest	11:0am	with	no		ok
12	7/26/17	chest/abd/pelvis	11:15am	without	no		ok
13	7/26/17	abd/pelvis	11:46am	without	no		ok
14	7/26/17	head	11:52am	without	no		ok
15	7/26/17	abd/pelvis	12:05pm	with	no		ok
16	7/27/17	head	8:39am	without	no		ok
17	7/27/17	head	8:46am	without	no		ok
18	7/27/17	head	8:54am	without	no		ok
19	7/27/17	chest	9:15am	with	no		ok
20	7/27/17	chest/abd/pelvis	9:24am	with	no		ok
21	7/27/17	head/C-spine	9:44am	without	no		ok
22	7/27/17	chest	10:02am	with	no		ok
23	7/27/17	abd/pelvis	10:12am	with	no		ok
24	7/27/17	head/C-spine	10:31am	without	no		ok
25	7/27/17	head	10:47am	without	no		ok
26	7/27/17	chest/abd/pelvis	11:06am	with	no		ok
27	7/27/17	chest	11:49am	without	no		ok
28	7/28/17	chest	8:48am	without	no		ok
29	7/28/17	head	8:57am	without	no		ok
30	7/28/17	abd/pelvis	9:03am	with	no		ok
31	7/28/17	abd/pelvis	9:38am	with	no		ok
32	7/28/17	abd/pelvis	9:51am	with	no		ok
33	7/28/17	chest	10:05am	with	no		ok
34	7/28/17	head/C-spine	10:15am	with	no		ok
35	7/28/17	chest	10:50am	with	no		ok
36	7/28/17	chest	10:59am	with	YES - New Medtronic	“stuck button”	ok
37	7/28/17	wrist	11:20am	without	no		ok
38	7/28/17	head	11:53am	without	no		ok
39	7/28/17	head	12:09pm	without	no		ok
40	7/28/17	chest/abd/pelvis	12:20pm	with	no		ok

Table 3. Dosimeter Results Showing Total Cumulative Radiation Received

Exposure Notification		Participant Override Level																
Participant Number	Name	Begin Date	End Date	Frequency	Dosimeter	Use	Energy	Dose Units (mrem)						Exceeded Level				
								Total DDE	Total LDE	Total SDE	Total Extremity	Fast Neutron	Thermal Neutron	Beta	Fetal	Wear Period	Year-to-Date	
03634	SPARE	2017-04-15	2017-05-15	1MO	PA	CHEST	M	8612	8612	8300							X	
		2017 YTD						8612	8612	8300								X

NOTES: Imaging indicates a dynamic exposure. Dosimeter reprocesses, second read agrees with reported dose.

## CONCLUSIONS:

- First purposeful exposure of insulin pumps to radiation to determine the effects of radiation on insulin pump functionality.
- Three insulin pumps received a total of 8,612 mRem of radiation. For comparison, the average person receives 350 mRem per year in background radiation exposure from cosmic and terrestrial sources.
- Therefore, the amount of radiation the insulin pumps received was a significant exposure over a short period of time
- The Animas (old) pump experienced a “Prime” alarm during radiation exposure. For this reason, the insulin pump was primed but developed a sustained darkened screen; therefore, it was removed from the experiment for the remainder of consecutive radiation exposure. Given the age of the Animas (old) pump, it is possible that the “prime” alarm was reflective of pump age and not truly related to radiation exposure. It cannot be determined if the alarm and darkened screen were related to radiation exposure or repetitive use of the a demonstration model insulin pump.
- Based on this novel research, it seems that there were no proven radiation induced effects on the new insulin pumps functions and abilities.
- Future research on insulin pumps receiving radiation exposure needs to be undertaken to truly understand if radiation exposure affects insulin pump function.

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