



The environmental impact of personal protective equipment in a pre and post COVID era in the ENT clinic

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Abstract

Purpose The use of single use plastic items and plastic wrapping has increased over the last number of decades. Outside of the medical field there has been a conscious drive to reduce single use plastic and reuse items to reduce the amount of waste we produce. We undertook this investigation to quantify our plastic waste production and generate ideas to reduce this volume.

Methodology Data was collected from a University Hospital ENT outpatient department via real-time recording methods using standard data collection forms. We measured plastic unit usage pre and post COVID restrictions and compared this to our number of patient encounters. Projections of plastic usage were determined via a hypothetical resumption of patient services model.

Results In total there were 440 patients included. In period one the mean units of plastic used per day was 65.1 (median 67; range 27–84). In the second period, the mean number of plastic units was 23.4 (median 22; range 1–7). Blue nitrile gloves and masks were the most commonly used single use items. The hypothetical projection model predicted a 147.6% increase in single use items following the introduction of COVID precautions.

Conclusion We have a duty of care not only to our patients but future generations of patients and the environment which we share. Single use items and excessive plastic wrapping have benefits in terms of convenience and sterility, but these conveniences can be easily extended to reusable types to limit our volume of waste, reduce our waste management costs and protect our environment.

Keywords Environment · PPE · Personal protective equipment · COVID · ENT · Outpatients · Waste · Climate change

Introduction

In recent years there has been an increased emphasis on reducing waste by recycling and reusing everyday items. The benefits are both environmental and economic as the cost of dealing with large quantities of waste place considerable strain on local authorities and government. The opposite would appear to be the case in medicine as single use items and plastic protective wrapping can be found on most items we use. With the benefits of single use items being quite clear, the unseen downside to most of us practicing in busy clinics is the cost of disposing of large quantities of single use plastic items and wrapping which generates a

financial drain on hospital resources and ultimately adds to the strained finances our hospitals try to navigate.

Before the COVID pandemic we began to take note of the large volumes of waste that were produced at the end of our routine clinics. Single use items were constantly being depleted while reusable items remained unused for long periods of time. The primary objective of this study was to determine our plastic usage per patient interaction, predict the volumes of waste that we may produce in the future and identify areas in which our consumption could be reduced.

Methods

Our study took place in the ENT surgery clinic at University Hospital Waterford (UHW). UHW serves a population of over 580,000 people from the surrounding counties. Specially designed data collection sheets were distributed to each member of the surgical team during outpatient clinics.

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These data sheets were divided into indications for use, including procedural equipment and personal protective equipment. As each team member used an item of single use plastic it was recorded in real time and collated at the end of the clinic. One unit of plastic usage was defined as any piece of equipment that included a plastic component and would be discarded after use. For example, an aural speculum would constitute one unit, as would a disposable PPE gown or plastic wrapping. The number of patients per clinic was also recorded to compare the volume of patients seen to the number of individual units used.

There were two data collection periods. One period ran for 10 days in February 2020 prior to the COVID pandemic lockdown measures. The second period ran for 9 days in April 2020, during the first national lockdown of COVID. During this time a re-triage of cases was undertaken, only urgent cases were brought to the clinic for assessment, other less urgent cases were seen in a virtual clinic. Precautions taken during flexible nasendoscopy and other outpatient tasks were adherent to international guidelines produced specifically for ENT and the COVID pandemic [1].

A hypothetical projection model was used to predict the number of plastic units used per patient in the future with new COVID precautions for ENT procedures. This model was based on the difference between means of plastic units used per patient in the pre and post-COVID era, this difference was then applied to our pre-COVID patient numbers. Descriptive statistics including measures of dispersion were used to describe results.

Results

Period 1

Period one ran during February 2020, a pre-COVID era, with no public health restrictions. There were 398 attendances at the outpatient clinic across two working weeks, totalling 10 days of data collection.

The mean number of patients seen per day was 39.8, (median 37, range 22–70). The mean number of plastic units per day was 65.1 (Median 67; Range 27–84). The breakdown for period one including individual items of plastic used and the number of patients seen per day is shown in Table 1. Analysing the most commonly used single use items in period 1, we found that blue nitrile gloves with 167 units, which equated to one pair for each unit, were the most frequently used item. Auroscope speculums were the next most commonly used amounting to 158 individual units; suction wand and packaging followed by suction tubing, suction tubing packaging and flexible nasendoscope packaging made up the next most commonly used units.

The full range of recorded items and their frequencies is shown in Fig. 1.

Figure 2 demonstrates the actual number of patients compared to the actual number of individual units of plastic generated on each day in the outpatient department. Given there was 398 patients in period one, the average number of units of plastic used per patient was 1.67.

Period 2

Period two ran over 9 days in April 2020 during the first national lockdown. During this period 42 patients attended the outpatient department, the mean number of patients per day was 4.6 (median 5; range 1–7). The most commonly used items of single use plastic in this period were blue nitrile gloves (66 units), followed by surgical masks (52 units) and blue gowns (22). The average number of units of plastic was 23.4 (median 22; range 6–55). The results of the various pieces of equipment and numbers of patients in period two is shown in Table 2.

The full range of items used, and number of patients seen is shown in Fig. 3.

The average number of units of plastic used per patient in this period was 5.09. Figure 4 demonstrates the actual numbers of patients compared to the actual number of individual units of plastic used in period 2.

Hypothetical projection model

Our mean use of patient to plastic ratio in the pre COVID era was 1:1.64. The mean number of patient to plastic units used in the second period was 1:5.09. The difference between these two means was used to calculate a hypothetical projection of the volume of plastic units used per patient in the setting of our pre COVID era numbers attending the outpatient department. On average there was a 3.45 times increase in the number of plastic units used. This would in turn translate in to a mean of 224.6 units of plastic being used per 10 day period of outpatient activity. This would be an increase in 147.6% on the previous volume. The hypothetical projection model is outlined in Fig. 5.

Discussion

Global temperatures continue to rise owing to our wasteful and resource intensive lifestyles and industries, with temperatures predicted to be in excess of 3 °C above pre industrial levels by the end of this century [2]. There has been concerted efforts put in place to reduce emissions such as the Paris Agreement, however political and economic interests often inhibit the good intentions of nations in complying with efforts to reach these goals.

Table 1 Period1 items of single use plastic and numbers of patients seen per day

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Total
Blue G						1					1
White G					1						1
Gloves	19	22	16	18	21	15	15	18	3	20	167
Nozzle	1	7		5	1			2	1	10	27
Scope	5	8	5	3	2	9	3	2		10	47
Auroscope	18	22	18	14	21	13	12	18	10	12	158
Suction	5	7	4	5	10	4	5	9	2	2	53
Suc tube	5	4	5	6	7	6	6	9	2	2	52
Jobson H	1					1	1		1	1	5
Swabs	3	3	1	4	1	2	1	1	1	2	19
Tongue D	3	1	6	5	5	5	3	1			29
Croc	1	1			1	5	3			1	12
Suc tip		2			10	7	1	6	1		27
St gauze	3				1	8			1	6	19
CS swab						1					1
NaCl										1	1
Syringe		1	1	2			1	1		1	7
Plaster								1		1	2
Lidocaine		1	1	1	1	1			2		7
Dental N		1	1		1				2		5
Dental S		1	1		1				1		4
Tillys			2							1	3
Steri strip		1	1								2
Splint		1	1								2
Patients	42	24	69	37	22	70	37	34	40	23	398

G gown Suc suction, H Horn, D Depressor, Croc crocodile forceps, St Sterile, CS Culture and Sensitivity, N Needle, S Syringe

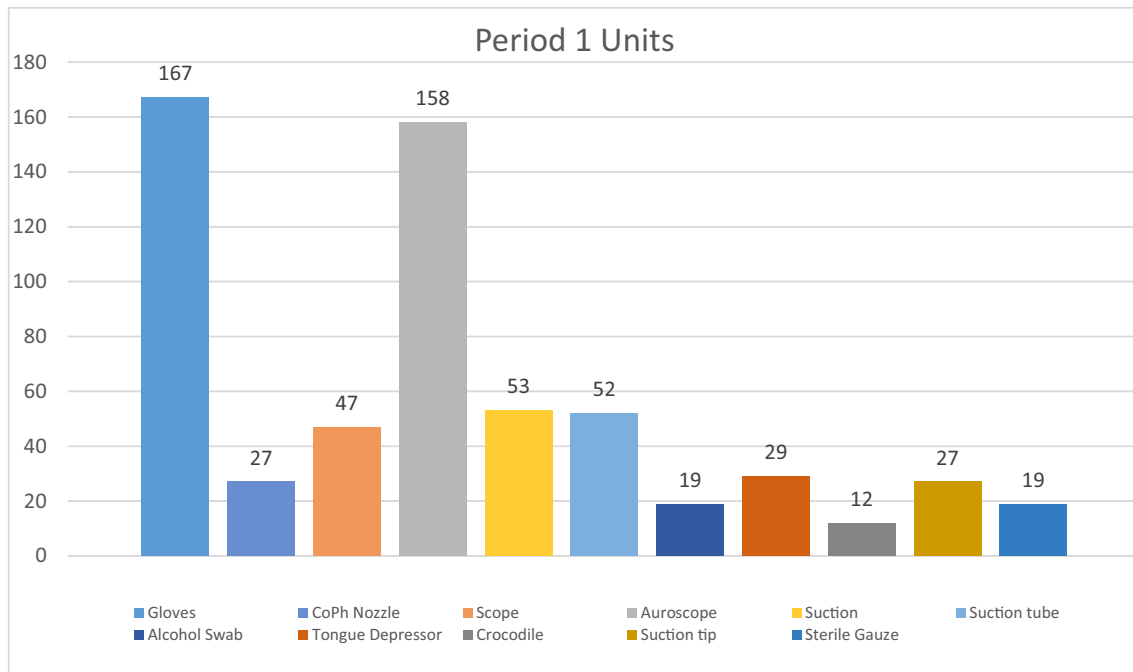
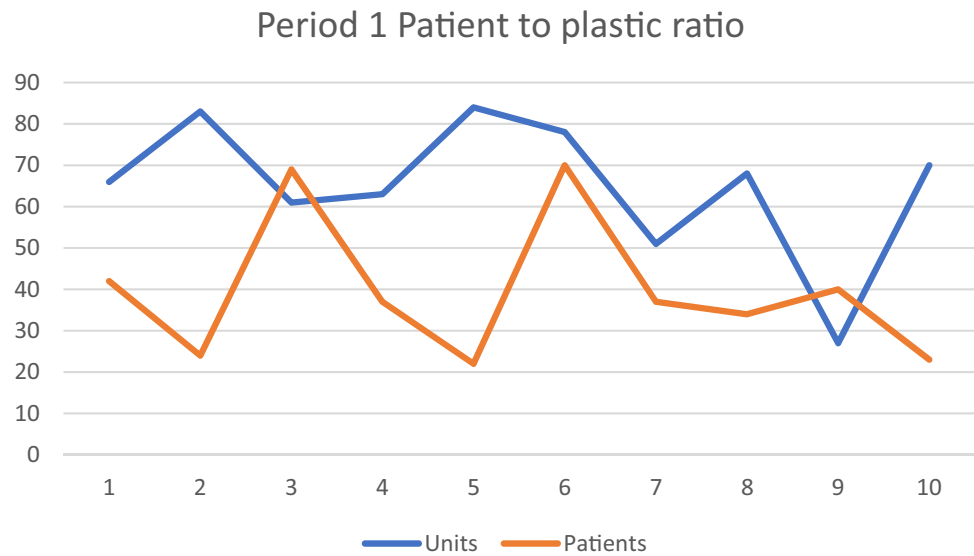


Fig. 1 The range and frequency of single use items in period 1

Fig. 2 Period 1 patient to plastic unit ratio**Table 2** Period 2

	D1	D2	D3	D4	D5	D6	D7	D8	D9	Total
Blue G	2			3	1	2	2	3	9	22
WhiteG		1								1
Yellow G		4	4							8
Gloves	5	4	4	8	2	6	6	6	11	66
Surg M	8	4	8	8	2	6	6	6	18	52
FFP2 M	2	2	2	1	1	1	2		4	15
Nozzle	1	1								2
Scope	1		2	1			2	1	4	11
Auroscope	1			2					1	4
Suc	1	2		2					2	7
Suc tube	1	2		2					2	7
Jobson H		1						1		2
Tongue D	1	1	2						4	8
Patients	7	5	1	5	5	5	1	6	7	42

G Gown, Surg M Surgical Mask, Suc suction, H Horn, D Depressor

The global health care sector is estimated to make up 4.4% of the global net emissions with the European Union being in the top three of global emitters for health care [3]. These emissions come in the form of the waste we produce but also in the less visible forms of manufacture and transport of equipment, all of which directly contribute to climate change and its consequences [4]. The deleterious consequences of waste and ultimately climate change can be seen in multiple reports and studies in the literature and range from heat related illness, air quality related illness, malnutrition from food scarcity and as we have seen with COVID19, vector-borne illness [5, 6]. These changes in climate patterns are not limited to one part of the planet, rather the impact has been shown to be global with evidence demonstrating that there is indeed an adverse effect on human health from

climate change in Europe [7]. The impact our own industry has on health would therefore appear to be contradictory to its own mission.

The environmental cost of operating rooms and other resource and waste heavy environments in the hospital have been investigated in the past [8–11]. While these areas of hospital medicine are visually impressive for the sheer quantities of waste they produce per procedure, the lesser seen impact is that of the outpatient department. This covert waste production is less likely to be abetted by efforts of waste reduction in comparison to the more overt environments such as the operating room [12]. As our study has shown, the impact that personal protective equipment and guidelines for the prevention of cross infection are estimated to lead to a 146% increase in single use plastics and their

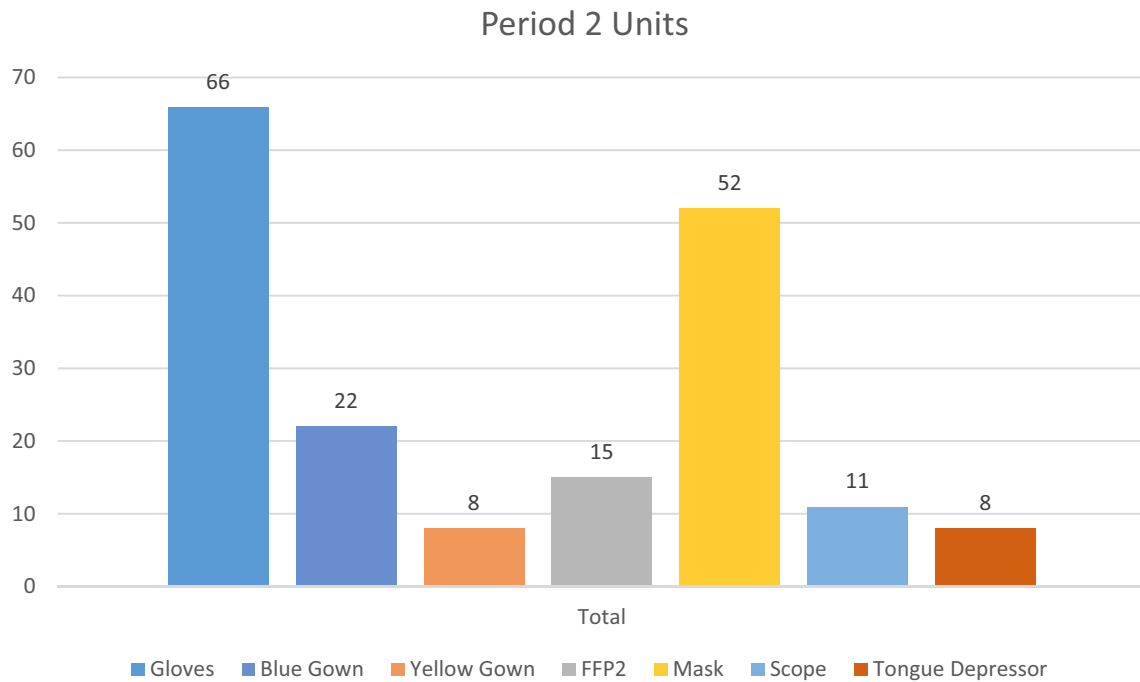
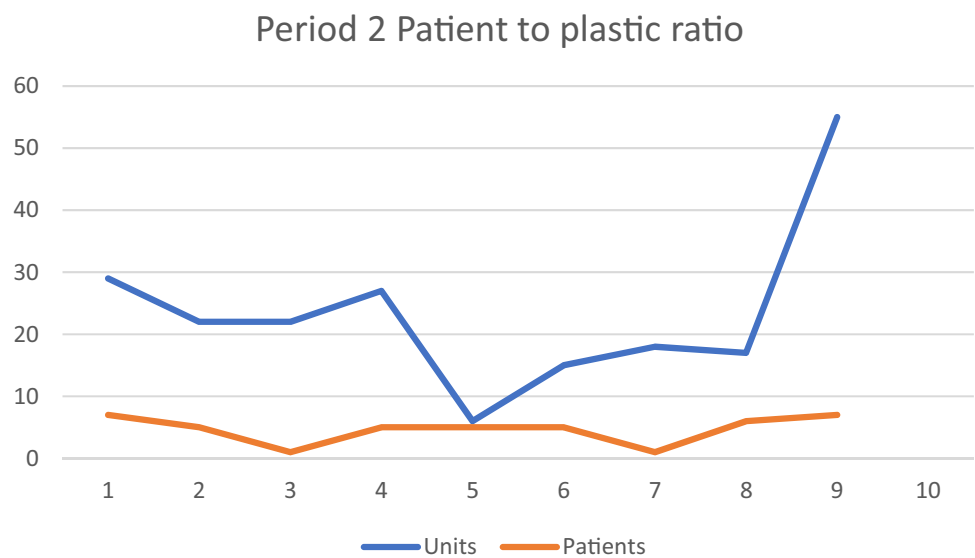


Fig. 3 The range and frequency of single use items in period 2

Fig. 4 Period 2, patient to plastic use ratio



subsequent need for disposal. A similar increment in the operating room or other environments, even with COVID precautions, is unlikely to be comparable.

Efforts to introduce environmentally more economic measures are under way, with many admirable and innovative moves towards sustainability [13–15]. Simple measures that could make a significant impact on our outpatient practice and waste production would be the use of reusable aural speculums, metallic tongue depressors and protective gowns that can be decontaminated after each use and

reused. The use of paper coverings for flexible nasendoscopes, suction tubing, suction tips and gauze packaging that can be easily recycled could drastically reduce the units of plastic used per patient. As is already the case with masks and eyewear, wear the same masks in as much as possible and reuse eye protection by thorough cleaning after each use. Figure 6 demonstrates the current quantity of plastic units used for some of the worst offending items, shown in blue. This figure also demonstrates the projected number of plastic units used and plastic waste generated

Fig. 5 Hypothetical projection of units of plastic used per patient numbers in the outpatient department

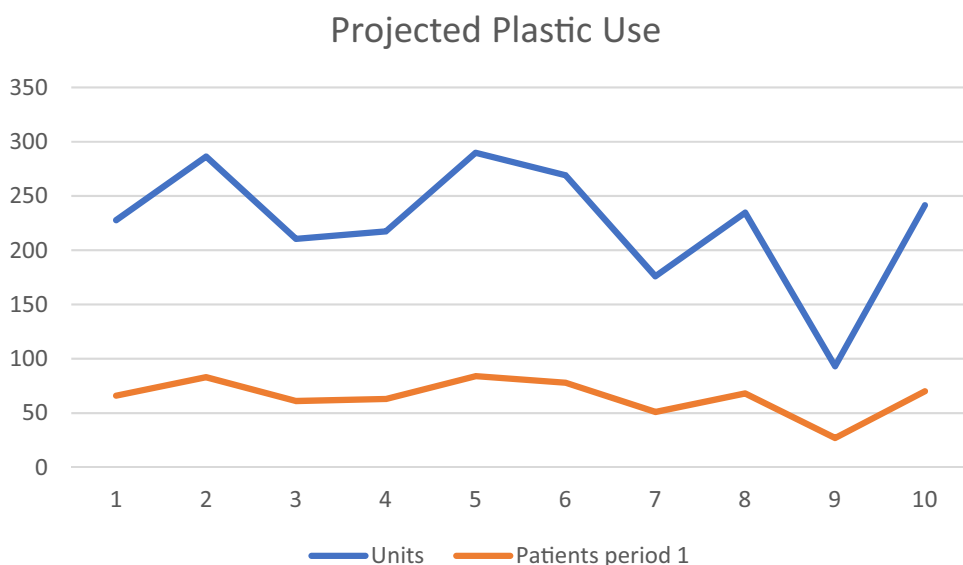
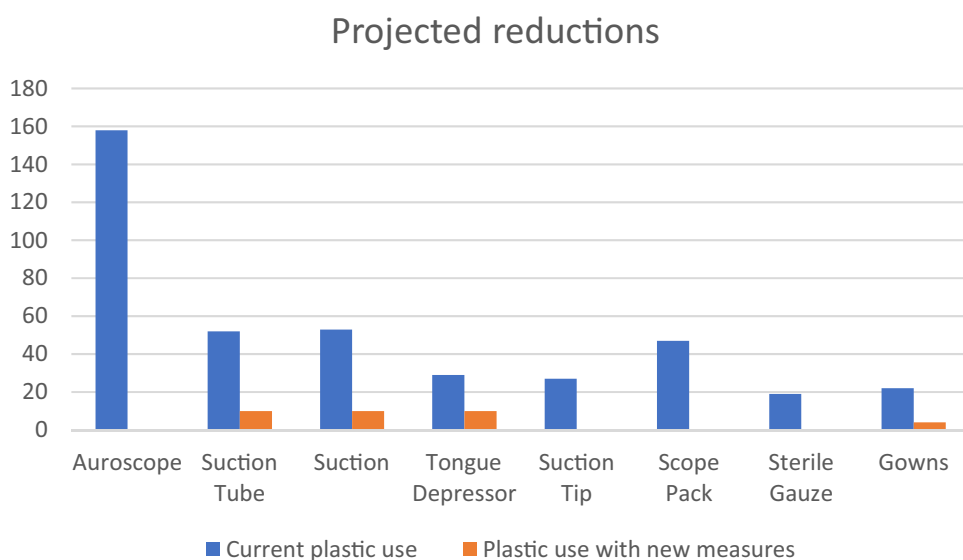


Fig. 6 Current plastic units used in the outpatient setting (blue). With reduced numbers of plastic units (orange) with the introduction of reusable and recyclable materials



if the same acceptable reusable items or paper coverings were used instead.

The decontamination of reusable items is already widespread practice across ENT departments. Flexible scopes are decontaminated on a regular basis often within the time frame and confines of the outpatient clinic. Other instruments such as the Crocodile forceps, Tilly’s dressing forceps and Tilley Henckel forceps would regularly be sent for decontamination prior to reuse. Furthermore, the standards and procedures are already in place for these services to be provided and therefore would not incur considerable burden on extending this to more reusable items [16].

The arrival of COVID19 has meant alterations to what was the pre-established status quo with respect to practice, equipment, procedures and even physicians attire, which

may be very different in the future [17]. The points of data collection were therefore different between the two periods due to the nature of COVID related work. In our first period of data collection, we had no FFP2 or FFP3 masks, and our use of full-length gowns was also considerably less. This reflects the rapid change in practice as filtered masks and surgical masks were understandably not a standard part of our attire pre-COVID.

There was a considerable difference in the number of patients who attended the ENT clinic during the first period versus the second period. This was due to the national public health measures aimed at mitigating the spread of the novel coronavirus by curtailing non-COVID clinical activity during the first coronavirus surge. Our patients were triaged in accordance with international guidelines to limit only urgent

referrals attending in person [1, 18]. Our numbers were also limited by the time required to ventilate rooms and the number of consultation rooms available as space was commandeered for donning and doffing. This of course may lead to a certain level of inclusion bias as urgent cases are more likely to have required endoscopy and ultimately increase the plastic units that would accompany them. However, looking at the numbers of scopes performed in the second period does not seem to support this as the primary driver in the dramatic increase in waste production. The role of virtual clinics will also inherently reduce the number of plastic units used as patients would not attend in person. The reduction that these clinics play in plastic use may also be temporary as many patients still require a physical appointment at some stage during their care. While virtual clinics have certainly found a utility in the post-COVID era, whether they remain a regular fixture of patient care will be determined with time. Certainly, the reduction in waste is welcome, however this must be balanced against providing satisfactory standards of care for our patients.

Despite the number of patients falling in period two, our use of single use items and plastic increased dramatically. With each flexible nasendoscope performed, not only would we have the original packaging but also the extra waste of disposable gowns, gloves and masks. This certainly led to the disproportionate increase in plastic units in comparison to the first period. Towards the end of period two, we also saw a sharp increase in the number of plastic units used, this was attributed to the temporary introduction of a double gloving practice for performing these procedures.

One of the limitations of our study was the confinement to the outpatient department. The application of our findings to other areas of the hospital including the emergency department or ward-based activities is therefore not possible to report. However, as the precautions implemented in our outpatient were also applied throughout the entire hospital, it is reasonable to consider that the waste generated in these departments was comparable. Our short data collection period was due to the exigencies of the service and the reallocation of staff within the hospital during the pandemic. While a larger data period would have led to a greater understanding of the pattern of plastic use, we feel that our research question is adequately answered given the restraints imposed by the pandemic. The single site nature of this study also limits its application across multiple institutions, however given that each hospital was following similar if not the same guidelines it can be assumed that waste trends are similar if not worse in departments that have a bigger capacity.

The environmental cost of this large volume of waste is clear, the economic benefit of reducing and reusing is also evident. The green health care program (GHCP) in Ireland aims to improve resource efficiency and help

prevent and reduce waste emissions from healthcare facilities. Irish hospitals produce 17,000 tonnes of waste each year, the costs of which are considerable to our health budget. While this figure is far below the top producers of health related emissions, it none the less contributes to the European Union's status as the third biggest contributor to global emissions [3]. The GHCP has conducted audits of components of waste material that was sent to landfill and found that 32% of the contents were recyclable components, this report estimated that correct disposal could lead to a saving of €380,000–€550,000 per year [19]. These savings could ultimately benefit other financially strained resources if funding for waste could be reduced.

The challenge to us as clinicians is to change our preference towards reusable items where possible. A reusable item will likely be more expensive at the outset, however the longevity of these items and the reduction in waste production is where the true value lies. The medical device industry will be encouraged to follow suit should our preferences alter. Cheaper packaging, reduced transport costs and increased production quality with reduced production quantity are all further economic benefits to the medical device industry that could be extended from the introduction of reusable items.

Conclusion

Primum non nocere, first do no harm, is the mantra of all physicians, a broader perspective needs to be applied to how this affects medical practice. Striking a balance between what is more harmful to the patients we serve has never been more pressing. Balancing the risks posed by reusing decontaminated or sterilised equipment and the certain harm future generations will suffer due to climate change as a result of wasteful practice is required. Given that our industry already reuses instruments on a regular basis in the operating theatre and in the outpatient setting it seems like a logical step to extend this to the worst offending items from our study. Proper informed balancing of these risks will require a detailed evaluation of the relative impact of single use versus reusable clinical items. Single use should not be the default. Health care providers have been called on in times of great need throughout history to act as leaders. The community at large is distinguishing itself during the current pandemic and we would encourage all involved in healthcare to continue doing so by reducing waste and engaging in incentives to limit harmful emissions.

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Data availability Available on request to corresponding author.

Declarations

Conflict of interest None to declare.

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