Tidsskriftet Tidsskrift for Den norske legeforening

Emergency preparedness medications can be used after the expiry date

PERSPECTIVES

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The author has completed the ICMJE form and declares no conflicts of interest.

A system for testing and storing expired pharmaceuticals can improve our medication preparedness in times of peace, disaster and war.

Wars, conflicts, climate emergencies and disasters call for medical treatment of the sick and injured – which in turn requires large quantities of medicine. Norway's military alert level has recently been raised, which means we need to plan for potential medication shortages. In 2023, we were given a taster of what may lie ahead with 1403 notifications of supply problems affecting key pharmaceuticals for people in Norway (1).

At the same time, medications that have reached their expiry date are being destroyed by pharmacies, care homes, hospitals, GP surgeries, the Armed Forces, A&E departments, ships, private health institutions, dental surgeries, airlines and NGOs. For the same reason, large quantities of medical consumables are being discarded and destroyed, ranging from basic supplies like tape, gauze swabs, catheter bags and ECG electrodes to costly medical technical equipment. This weakens our preparedness and represents a considerable cost. Moreover, the process of manufacturing and destroying pharmaceuticals has an environmental impact, and in large hospitals the generation of waste is colossal.

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Since 1989, the United States Armed Forces have been working with the Food and Drug Administration (FDA) on the SLEP project (*Shelf Life Extension Program*) to test medical supplies and medications and extend their expiry date (2). The objective is for the Armed Forces to reduce their expenditure on pharmaceuticals. The findings are not yet available in the public domain, but the project has resulted in several publications on the topic and listings of medications that are safe to use after their expiry date.

A key criterion for a medication to be deemed usable after the expiry date is that 95 % of its active substances are chemically available at the time of testing. Studies of 122 types of medicine stored in optimal conditions have shown that the expiry date can be extended by at least a year, on average by 66 months and by a maximum of 278 months, and that 90 % of the pharmaceuticals were safe to use 15 years after their expiry date (3, 4).

Optimal storage conditions

Most pharmaceuticals are chemically stable when stored in optimal conditions: dark, dry, normal humidity level (50 %) and room temperature (15–25°C). Some medications must be kept in the fridge and protected from sunlight. This is specified in the summary of product characteristics (SPC) which is found in the Norwegian Pharmaceutical Product Compendium and elsewhere. Glass ampoules provide good storage since they are impermeable to oxygen and moisture.

Expiry dates

A medication's expiry date is specified in the SPC. Their shelf life is commonly set to five years, which is normally the maximum period stipulated by the manufacturer (5). The expiry date is rarely set for pharmacological reasons.

Table 1 (6) lists key medications that were repeatedly tested under the SLEP project and found to be stable after their expiry date. The assessment criteria included potency, purity, water content and appearance. Furthermore, tablets and capsules had their dissolution rate tested, while powders, injectable solutions and autoinjectors were tested for pH and preservatives. Autoinjectors also had their mechanical function tested. Note that variations in the expiry date extension for a specific medication were rarely due to chemical testing; they were generally based on changes in appearance or damaged packaging (6).

Table 1

Average (min–max) expiry date extension for 34 medications (listed alphabetically) deemed to be stable after their expiry date (6).

Medication	Formulation[1, 2]	Average number of months by which the expiry date was extended (min–max)
Amoxicillin	Tablets	23 (22–23)
Ampicillin	Capsules	49 (22–64)
Atropine	Autoinjector	31 (25–38)
Atropine sulfate/pralidoxime chloride	Autoinjector	31 (25–38)
Benzylpenicillin	Powder for injectable solution	70 (61–84)
Bupivacaine	Injectable solution	88 (79–95)
Calcium chloride	Infusion fluid	81 (66–106)
Cefalexin	Capsules	57 (28–135)
Ceftriaxone	Powder	60 (44–69)
Cimetidine	Tablets	67 (59–75)
Ciprofloxacin	Tablets	55 (12–142)
Ciprofloxacin	Solution	32 (25–40)
Dexamethasone	Autoinjector	61 (24–93)
Dicloxacillin	Powder	56 (28–116)
Dobutamine	Concentrate for infusion fluid	47 (29–79)
Doxycycline	Capsules	50 (37–66)
Edrophonium	Injectable solution	65 (33–114)
Ephedrine	Injectable solution	46 (21–94)
Erythromycin	Powder	60 (38–83)
Fentanyl	Injectable solution	84 (70–96)
Glucose 10 %	Injectable solution	25 (23–29)
Hydrocortisone	Injectable solution	43 (37–56)
Ketamine	Injectable solution	64 (42–87)
Mannitol	Infusion fluid	66 (21–109)
Mepivacaine	Injectable solution	41 (33–45)
Naloxone	Injectable solution	77 (60–95)
Naproxen	Tablets	52 (46–62)
Neostigmine	Injectable solution	60 (31–78)
Pethidine	Injectable solution	89 (32–128)
Phenytoin	Injectable solution	63 (29–100)

Medication	Formulation[1, 2]	Average number of months by which the expiry date was extended (min–max)
Potassium iodide	Tablets	69 (28–184)
Protamine sulfate	Powder	64 (57–77)
Sodium chloride	Infusion fluid	72 (40–108)
Sodium hydrogen carbonate	Injectable solution	55 (14–101)

[1]Medications are listed as capsules/tablets/powder based on the formulation used in the USA.

[2]Registration-exempted autoinjectors are used in Norwegian emergency departments and by the Norwegian Armed Forces.

Suboptimal storage conditions

Studies suggest that freeze-dried plasma stored in army field conditions is safe to use two years after the expiry date, with only a slight reduction of efficacy (7).

Tranexamic acid, which is used for prehospital bleeding control, has been tested after being kept in field conditions at temperatures between –20 and 50 °C for 12 weeks, without any demonstrable loss of potency in vitro (8).

American researchers who found and tested various tablets from a closed-down pharmacy, showed that 86 % of medications that had expired 28–40 years ago, had at least 90 % of their active substances intact (8). When medications had degraded, the cause was likely to be ingress of moisture through the packaging, leading to hydrolysis. However, acetylsalicylic acid had probably degraded spontaneously (3).

In the atmosphere, there is weightlessness and higher background radiation. In 2015, the international space station sent medications by satellite to Earth in order to study medication degradation (9). The medications' use-by date had already expired, but eight out of nine were nevertheless approved since more than 90 % of their active substances remained. Melatonin was not approved.

> ***«There is much to suggest that many medications that have been stored in suboptimal conditions continue to have the desired effect»***

In 2022, nine drugs intended for use by emergency medical services were deposited with two rescue helicopters in Switzerland and exposed to temperature fluctuations between –1.2 and 38.1°C for one year. According to the manufacturers, the drugs had to be kept at room temperature, but the researchers found no demonstrable degradation or loss of potency after the experiment. The drugs that were tested included adrenalin 1 mg/ml, noradrenaline 1 mg/ml, amiodarone 150 mg/3 ml, midazolam 15 mg/3 ml,

fentanyl 100 ug /2 ml, naloxone 0.4 mg/1 ml, etomidate 20 mg/10 ml, ketamine 100 mg/2 ml and rocuronium 100 mg/10 ml. Amiodarone showed a tendency towards transient micro-crystallisation at low temperatures (10).

There is much to suggest that many medications that have been stored in suboptimal conditions continue to have the desired effect. They should therefore be considered for use in situations where resources are scarce. It should also be widely investigated what expired medications can be administered to patients and injured people in a crisis if other medications are not available.

A system that allows some medications to be put into storage rather than being destroyed after the expiry date can help with providing simple and inexpensive medication preparedness at a local level. Now is the time to put this issue on the agenda.

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Publisert: 9 September 2024. Tidsskr Nor Legeforen. DOI: 10.4045/tidsskr.24.0248
Received 30.4.2024, first revision submitted 5.6.2024, accepted 19.6.2024.